Exploring the dynamics of racial food security gaps in the United States

Ian K. McDonough1 · Manan Roy2 · Punarjit Roychowdhury3

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Abstract
Household-level food insecurity is one of the largest public health concerns facing millions of people in the United States today. Although recent work has highlighted gaps in food security rates between minority and non-Hispanic white households, little is known about how these households evolve through the overall distribution of food security over time. As such, we employ nonparametric estimators of distributional mobility to household-level data on food security from the Early Childhood Longitudinal Survey, Kindergarten Class of 1998–1999 study. Results suggest that Hispanic and non-Hispanic white households with children are equally mobile in the long run whereas non-Hispanic black households with children tend to be less upwardly mobile and more downwardly mobile in food security status over time.

Keywords Food security · Mobility · Poverty · Racial disparity · Transition dynamics

JEL I12 · I18

1 Introduction

Food insecurity is one of the most significant public health concerns facing the United States today. As noted by Gundersen et al. (2011, p. 281), “the prevalence of food insecurity is of great concern to policy-makers and program administrators, a concern heightened by its many demonstrated negative health consequences.” This is
particularly true when looking at childhood health outcomes. In particular, food insecurity has been linked with greater cognitive problems (Howard 2011), an increase in aggressive behavior (Whitaker et al. 2006), an increase in behavioral and mental issues (Alaimo et al. 2002; Huang et al. 2010), higher probabilities of being diagnosed with asthma (Kirkpatrick et al. 2010), and overall poorer health (Cook et al. 2004, 2006). Further, King (2018) has recently documented an association between housing instability and household-level food security.

While true that food insecurity rates have leveled off since the Great Recession of 2009, the prevailing number of food insecure households remains startlingly high. In particular, figures from 2016 suggest that 12.3% of U.S. households (15.6 million households) were food insecure, meaning these households were classified as lacking consistent access to food required for an active, healthy life (Coleman-Jensen et al. 2017). Among these 15.6 million food insecure households, 6.1 million were classified as being very low food secure (4.9% of U.S. households). Among households with children in 2016, 8% had food insecure children with only 0.8% of those households being classified as very low food secure. These same figures were 9.4% and 1.1% in 2014 and 10% and 1.2% in 2012, respectively (see, Table 1B, Coleman-Jensen et al. 2017).

In addition to the recent rates of food insecurity noted above, it is well documented that household rates of food insecurity differ along the dimension of race. In particular, Coleman-Jensen et al. (2017) report that 22.5% of households headed by blacks and 18.5% of households headed by Hispanics were food insecure in 2016 compared to the national average of 12.3%. The authors further report that only 9.3% of households headed by whites were classified as food insecure, resulting in a food insecurity gap of 13.5 percentage points and 9.2 percentage points between blacks and whites and Hispanics and whites, respectively. Additionally, these observed gaps in food insecurity have been relatively persistent. Even though the gaps in food security have slightly narrowed over recent years, the average gap in food insecurity over the time period of 2013–2015 averaged 14.2 percentage points for black households versus white households and 11.4 percentage points for Hispanic households versus white households (Coleman-Jensen et al. 2016, 2015, 2014).

In light of the well documented racial disparities in food security status, this study aims to explore the dynamics of the racial food security gaps by documenting how a household’s food security status evolves over time. In particular, and using the Early Childhood Longitudinal Survey, Kindergarten Class of 1998–1999 (ECLS-K) data, we employ nonparametric measures of distributional mobility to estimate the likelihood that minority and non-Hispanic white households with children will move upward, downward, or not at all through the distribution of the food security over time. Specifically, our analyses and results pertain to the mobility dynamics of non-Hispanic black, non-Hispanic white, and Hispanic households with children.

The reasons for performing such an exercise are threefold. First, solely evaluating the racial gaps in food security in levels without understanding how households transition through the distribution of food security over time is incomplete. Not taking into account household-level transition dynamics may lead to inaccurate conclusions with respect to the severity of the food security gap. For example,

1 These figures include households with and without children.
suppose there is a measurable gap in food security status between minority households with children and non-Hispanic white households with children. At the same time, suppose that the movement through the food security distribution is the same between minorities and non-Hispanic whites. In such a situation one could imagine such movements through the food security distribution leading to all households being evenly dispersed, in a proportional sense, across food security distribution over time relative to the distribution of food security at any particular point in time. Further, it is reasonable to think that a small gap in food security between non-Hispanic whites and minorities with no distributional movement is more of a concern compared to a state where the racial gap in food security is modest yet the households are highly mobile. Although the disparity in levels is relatively small in the first case, it is persistent. Similar to what has been noted by Kopczuk et al. (2010) and Glewwe (2012) in the income inequality literature, inequality in food security by itself is not meaningful; rather, it is both the racial food security gap in levels and the underlying mobility dynamics that matter for assessing the degree of food insecurity between white and minority households.

Second, understanding racial disparities in mobility patterns of food security is important for the creation of effective policy. On the one hand, if mobility in food security is low for minority households relative to non-Hispanic white households, such that the minority households find themselves persistently food insecure, then policy should perhaps target the reduction in long term economic vulnerability (e.g. through acquisition of physical assets or human capital) of minorities. On the other hand, if mobility is high across all households, and the racial food security gap is transitory—e.g. certain households do not have access to sufficient food for all members during periods of low income and volatile prices—then policy may be more effective if targeted towards sources of income/price volatility and/or credit and insurance markets. In fact, and as noted by Ribar and Hamrick (2003), transient food insecurity (as opposed to chronic food insecurity) would also support the general design of food stamp programs for low income households and, in particular, for those households that have unexpected declines in income.

Third, poverty and food insecurity are often lumped together under the assumption that those who are food insecure are necessarily poor (and vice versa). As noted by Millimet et al. (2018), Gundersen (2013), and Ribar and Hamrick (2003), food insecurity and poverty are not synonymous. Meaning, households in a state of poverty are often food secure while many non-poor households are officially food insecure. For example, 61.7% of households with annual incomes below the official poverty line were food secure in 2016, while 5.6% of the households with incomes exceeding 185% of the poverty line were food insecure (Coleman-Jensen et al. 2017). Ribar and Hamrick (2003, p. 21) in this context note, “poverty and food insufficiency [a severe form of food insecurity] are related, yet distinct, processes…if a household is able to borrow and save, bouts of poverty need not result in food problems.” As such, a careful analysis of the racial gaps in food security dynamics, distinct from poverty dynamics, is needed to better understand the economic hardship

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2 Using data from the ECLS-K, the authors confirm that food insufficiency depends on more than simply household-level poverty status, a result that indicates that poverty and food insufficiency proxy for different aspects of economic hardship.
associated with food insecurity. Considering both the racial food security gap in levels and the underlying dynamics behind the gap helps in understanding whether or not what is observed in the data is a genuine problem, or more of an artifact of when household-levels of food security are measured.

Our results are compelling. We find that relative to non-Hispanic white households with children, non-Hispanic black households with children tend to have a lower probability of transitioning out of the bottom of the food security distribution while at the same time having a higher probability of falling from a state of high food security back into a state of food insecurity. Such mobility dynamics, if allowed to persist over the long-run, would lead to 62% of non-Hispanic black households with children achieving high food security status in the steady-state compared to 88% of non-Hispanic white households with children achieving high food security status. Further, 19% of non-Hispanic black households with children would be classified as food insecure in the steady-state relative to only 7% of non-Hispanic white households with children. Taken together with the documented gap in food security status between non-Hispanic white and non-Hispanic black households with children, the mobility dynamics suggest that we would see very little racial convergence in food security status unless we can better understand how to lift non-Hispanic black households with children out of a state of food insecurity while at the same time keeping households in some state of food security once such status is achieved.

Interestingly, our results for Hispanic households with children present a different picture. Specifically, Hispanic households with children, when averaged over all time periods, have a lower probability of being entrenched in a state of food insecurity relative to non-Hispanic white households with children. As well, and similar to non-Hispanic black households, Hispanic households with children are more likely to fall out of a state of high food security once achieving such status relative to non-Hispanic white households with children. However, this downward transition out of a state of high food security for Hispanic households relative to white households with children is less severe compared to the same gap in downward mobility between non-Hispanic black households and non-Hispanic white households with children.

When comparing Hispanic households with children directly with non-Hispanic black households with children, we find mobility dynamics similar to what is found when comparing non-Hispanic white households to non-Hispanic black households. Such long run mobility dynamics would lead to the steady-state food security distribution to look similar between Hispanic and non-Hispanic white households but at odds with non-Hispanic black households. In particular, in the steady-state 84% of Hispanic households with children would be classified as high food secure (compared to 88% for non-Hispanic white and 62% for non-Hispanic black households with children) while 10% of Hispanic households with children would settle in a state of either low or very low food security (compared to 7% of non-Hispanic white and 19% of non-Hispanic black households with children). Even after conditioning on household-level socioeconomic status, we find evidence that non-Hispanic black households are the most vulnerable group when compared to non-Hispanic white and Hispanic households.

The rest of the paper is organized as follows. Section 2 summarizes the existing literature. Section 3 describes the data. Section 4 presents the mobility measures. Section 5 discusses the results. Section 6 concludes.
2 Literature review

The persistence of food insecurity has been quantified by several studies using nationally representative samples from the United States (see for e.g. Jyoti et al. 2005; Hernandez and Jacknowitz 2009; Wilde et al. 2010; Rank and Hirschl 2009; Howard 2011) as well as samples from small scale state level surveys (see for e.g. Heffin et al. 2005, 2007; Ip et al. 2015). While these studies measure persistence in, or duration of, food security, they do so purely to describe their data as a routine exercise. In other words, the focus of these papers is not on measurement of underlying transition dynamics associated with food security, but on the relationship between food security and health or between food security and educational outcomes. Moreover, none of the above studies examine the differences in mobility patterns of non-Hispanic black, non-Hispanic white, and Hispanic households, which is the focal point of our paper.

To our knowledge, there are only two studies that—in addition to analyzing the overall persistence in food security status—examine whether persistence in food security varies across the distribution of race. The first of these is a study by Ribar and Hamrick (2003) who utilize the Survey of Income and Program Participation and the follow-on Survey of Program Dynamics to analyze food security across two points in time using households with children. The authors find that about 4.5% of married couples experienced food insecurity at least once and about 0.5% experienced food insecurity at both points in time. Although the descriptive statistics in their study suggest food insecurity rates were substantially higher among blacks and Hispanics relative to whites, results from hazard models suggest that only blacks were significantly more likely to move into a state of food insufficiency relative to whites. However, Hispanics’ chances of entering into and exiting out of a state of food insufficiency were not statistically different from their white counterparts.

Burke et al. (2012), using the ECLS-K data, examine both the overall persistence in food insecurity and the heterogeneity in persistence across racial lines. Here the authors define persistence, and the degree of persistence, as a function the number of consecutive periods a household is classified as food insecure. The authors find that the prevalence of households that experience food insecurity at least once was 35.0% across all time periods, with 21.9% experiencing nonpersistent and 13.1% experiencing persistent food insecurity. Out of all households, black households had the highest incidence of nonpersistent and persistent food insecurity at rates of 34.4% and 23.2%, respectively. White households had the lowest prevalence of food insecurity, with 23.9% of households experiencing food insecurity in one or more time periods. In addition, nonpersistent and persistent food insecurity was lowest in white households followed by Hispanic households.

Our study is most similar to Burke et al. (2012), but differs in methodology. Specifically, Burke et al. (2012) analyze the racial gap in food security simply by deriving the proportion of households that are classified as either persistent or persistent.

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3 The majority of these studies define food security based on the USDA 18-question Core Food Security Module.

4 Other studies that quantify the racial gaps in food security include Nam et al. (2015), Kirkpatrick et al. (2012), Hiza et al. (2013), Anderson et al. (2016). However, none of these analyze the mobility patterns in food security.
nonpersistent with respect to being food insecure. We on the other hand, and
described in detail below, estimate entire Markov chain transition matrices to char-
acterize the mobility patterns of households, by race, across the entire distribution of
food security. These estimated mobility dynamics can then inform whether there are
racial gaps in directional movements through the distribution over time. Said another
way, the estimated mobility dynamics can highlight whether certain groups are
getting “stuck” in poor state of food security versus being entrenched in a very
positive state. Further, having derived such transition dynamics allows us to evaluate
how households are distributed across the food security distribution in a longer-run,
steady-state equilibrium.

3 Empirics

3.1 Measure of Food Security Mobility

To explore the racial differences in food security dynamics, we construct Markov
chain transition matrices capturing the entirety of household transition dynamics over
time. Specifically, let $y_{it}$ denote the raw food security score for household $i$, $i = 1, ..., N$, in time $t$, $t = t_0, t_1$, $t_0 \neq t_1$, and let $F_{t_0}(\cdot)$ and $F_{t_1}(\cdot)$ denote the cumulative dis-
tribution function (CDF) of raw food security scores for households in two distinct
time periods $t_0$ and $t_1$. Further, let $F_{t_0,t_1}(y_{t_0}, y_{t_1})$ denote the bivariate joint CDF, where $y_t \equiv y_{1t} \cdots y_{Nt}$.

To summarize and provide intuition to the movement through the distribution of
food security captured by $F_{t_0,t_1}(y_{t_0}, y_{t_1})$, we construct a $K \times K$ transition matrix, $\Pi_{t_0,t_1}$, given by

$$\Pi_{t_0,t_1} = \begin{bmatrix}
\pi_{11} & \cdots & \cdots & \cdots & \pi_{1K} \\
\vdots & \ddots & \ddots & \ddots & \vdots \\
\vdots & \ddots & \ddots & \ddots & \vdots \\
\pi_{K1} & \cdots & \cdots & \cdots & \pi_{KK}
\end{bmatrix}$$

where elements of (1) are represented by

$$\pi_{kl} = \frac{Pr[F_{t_0}(y_{t_0}) \in k, F_{t_1}(y_{t_1}) \in l]}{Pr[F_{t_0}(y_{t_0}) \in k]} \quad k, l = 1, ..., K,$$

and $k, l$ denote various partitions of the food security distribution. Thus, $\pi_{kl}$ is
intuitively a conditional probability depicting the probability of moving to some state
of food security $l$ in time $t_1$ conditional on being in some state of food security $k$ in
time $t_0$.

To derive racial differences in these transition probabilities, we refine (2) by
conditioning on covariates given by $X$. By doing such (2) simply becomes

$$\pi_{kl} = \frac{Pr[F_{t_0}(y_{t_0} | X = x) \in k, F_{t_1}(y_{t_1} | X = x) \in l]}{Pr[F_{t_0}(y_{t_0} | X = x) \in k]} \quad k, l = 1, ..., K,$$

where the covariate of interest is race.
In obtaining the above mobility measures in practice, we first construct the empirical CDF in each time period by pooling all households of all races for which raw food security scores are non-missing. Using definitions of food security provided by the USDA, we assign each household to a particular state of food security where the various states of food security are food insecure, marginal food secure, and high food secure (i.e. \( K = 3 \)). We then track how households move through the distribution of food security from one period to the next. The racial groups of interest in the current analysis center on those households classified as either non-Hispanic black, Hispanic, or non-Hispanic white. Lastly, to get standard errors for the mobility estimates, we employ the paired jackknife method utilizing appropriate replicate weights provided in the data.

### 4 Data

The data come from the Early Childhood Longitudinal Survey, Kindergarten Class of 1998–1999 (ECLS-K). The survey is conducted by the National Center for Education Statistics (NCES) and is given to a nationally representative sample of over 20,000 students from 1000 different schools and tracks their progress and household experiences during early childhood. Although the full sample was surveyed over seven waves, questions regarding household food security status were only assessed in four waves: spring kindergarten, spring third grade, spring fifth grade, and spring eighth grade. Additionally, the food security questions surveyed come from the USDA’s Core Food Security Module (CFSM).

We define three measures of food security following official definitions for all waves of the data where food security data was collected. Specifically, a household with children is classified as high food secure if it affirms zero questions in the CFSM. As well, a household with children is classified as marginally food secure if it affirms at least one, but less than three, questions in the CFSM. Lastly, a household with children is classified as food insecure if it affirms three or more questions in the CFSM.

In estimating the transition dynamics, we do so over four different time periods: spring kindergarten to spring third grade, spring third grade to spring fifth grade, spring fifth grade to spring eighth grade, and spring kindergarten to spring eighth grade. We utilize the estimated transition matrix over the longest time horizon of spring kindergarten to spring eighth grade to derive the Markov chain steady-state distributions. We retain children for whom we have valid measures of race and household-level food security across all four waves. Doing such results in a final sample consisting of 642 non-Hispanic black students, 1210 Hispanic students, and

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5 United States Department of Education. Institute of Education Sciences. National Center for Education Statistics. Early Childhood Longitudinal Study [United States]: Kindergarten Class of 1998–1999, Kindergarten-Eighth Grade Full Sample. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2014-03-20. See https://doi.org/10.3886/ICPSR28023.v1. Last Accessed: July 30, 2018.
4970 non-Hispanic white students (for a total of 6822 students). In all cases, appropriate sample weights are used. Table 1 presents the descriptive statistics.

### Table 1 Descriptive statistics

|                  | Full sample | White    | Black    | Hispanic  |
|------------------|-------------|----------|----------|-----------|
| **(A) Spring kindergarten** |             |          |          |           |
| HFS              | 0.837 (0.370) | 0.886 (0.318) | 0.767 (0.423) | 0.744 (0.436) |
| MFS              | 0.076 (0.265) | 0.057 (0.232) | 0.109 (0.312) | 0.105 (0.307) |
| FI               | 0.087 (0.283) | 0.057 (0.232) | 0.123 (0.329) | 0.151 (0.358) |
| SES              | 0.023 (0.792) | 0.277 (0.719) | −0.411 (0.769) | −0.388 (0.680) |
| **(B) Spring third grade** |             |          |          |           |
| HFS              | 0.858 (0.349) | 0.913 (0.281) | 0.739 (0.440) | 0.790 (0.407) |
| MFS              | 0.069 (0.254) | 0.042 (0.201) | 0.130 (0.337) | 0.099 (0.299) |
| FI               | 0.073 (0.260) | 0.044 (0.206) | 0.131 (0.337) | 0.110 (0.314) |
| SES              | −0.040 (0.801) | 0.220 (0.745) | −0.466 (0.705) | −0.475 (0.692) |
| **(C) Spring fifth grade** |             |          |          |           |
| HFS              | 0.833 (0.373) | 0.898 (0.303) | 0.709 (0.455) | 0.741 (0.438) |
| MFS              | 0.068 (0.251) | 0.042 (0.200) | 0.128 (0.334) | 0.095 (0.294) |
| FI               | 0.099 (0.299) | 0.061 (0.239) | 0.164 (0.370) | 0.164 (0.370) |
| SES              | 0.019 (0.799) | 0.232 (0.751) | −0.427 (0.700) | −0.441 (0.693) |
| **(D) Spring eighth grade** |             |          |          |           |
| HFS              | 0.833 (0.373) | 0.886 (0.318) | 0.669 (0.471) | 0.815 (0.388) |
| MFS              | 0.073 (0.259) | 0.045 (0.208) | 0.168 (0.374) | 0.071 (0.257) |
| FI               | 0.095 (0.293) | 0.069 (0.253) | 0.163 (0.370) | 0.114 (0.317) |
| SES              | 0.072 (0.787) | 0.165 (0.747) | −0.439 (0.673) | −0.486 (0.702) |

**Notes:** Standard deviation in parentheses. In all cases appropriate sample weights were used as provided by the ECLS

*HFS* high food secure, *MFS* marginal food secure, *FI* food insecure, *SES* socioeconomic status

5 Results

In this section we present the estimated transition dynamics for non-Hispanic black, Hispanic, and non-Hispanic white households. Based on the estimated transition matrices, we then derive the Markov chain steady-state distributions by race. Lastly, we employ a regression framework to assess the impact of various observables, as captured by socioeconomic status, on the racial gap in these estimated mobilities.

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6 Note, the race/ethnicity of the student is what determines the racial/ethnic nature of the household.

7 For the sake of brevity when discussing the results, we drop the qualifiers of “non-Hispanic” and “with children” when referring to particular households. However, the term “black” still implies “non-Hispanic black” and “white” still implies “non-Hispanic white.” Also, if not explicitly stated, any reference to “households” is to still be interpreted as “households with children.”
5.1 Black–white mobility gap

In Table 2 we present estimated transition probabilities separately for white households and black households, as well as the differences between transition probabilities for these two groups. We estimate the transition probabilities for food security between kindergarten and third grade (panel (A)), third and fifth grade (panel (B)), fifth and eighth grade (panel (C)), and finally kindergarten and eighth grade (panel (D)). While the transition probabilities reported in panels (A)–(C) are meant to capture short run dynamics of food security, the final panel (D) is likely to capture a more long run mobility in food security.

5.1.1 Black–white staying probabilities

We begin our discussion focusing on staying probabilities, i.e. the diagonal elements of the transition matrices. That is, the probability of remaining classified in a particular state of food security in the terminal period conditional on being classified in that same state in the initial period. Focusing first on the staying probabilities associated with being “stuck” in a state of food insecurity, we find that, for all panels except panel (C), black households have a higher probability of remaining food insecure compared to white households over time. According to the transition probability estimates reported in panel (C), which traces the dynamics of food security from fifth to eighth grade, white households appear to have a slightly higher probability of staying food insecure relative to black households. However, it is noteworthy that this difference is not statistically significant at conventional levels.8

Turning our attention to the probability of remaining marginally food secure, we find that in all the cases black households have a higher probability of remaining marginally food secure compared to white households. For example, between kindergarten and third grade, black households have an 11 percentage point higher probability of staying marginally food secure compared to white households, and between fifth and eighth grade, this difference in the likelihood of remaining marginally food secure is about 14 percentage points. The gap in the likelihood of staying marginally food secure over the longest time horizon (i.e., between kindergarten and eighth grade) is even more stark. Specifically, as per our estimates reported in panel (D), black households, compared to white households, are estimated to have almost a 26 percentage point higher probability of remaining marginally food secure in eighth grade conditional on being marginally food secure in kindergarten, with the estimated gap being statistically significant at conventional levels. As a note of caution, it is hard to infer whether or not this finding is positive from the perspective of black households. On the one hand, black households seem to not climb out of a state of marginal food security and into a state of high food security, relative to white households, over time. On the other hand, having a higher probability of remaining marginally food secure over time would suggest that black households, relative to white households, do not fall from a state of marginal food security into a more desperate state of food insecurity. This is why the extremes of the distribution are arguably more informative.

8 Conventional levels are $\alpha = 0.01$, $\alpha = 0.05$, or $\alpha = 0.10$. 
### Table 2 Estimated transition matrices, black and white household dynamics

| Panel          | Period $t_0$ | FI White | FI Black | B–W  | MFS White | MFS Black | B–W   | HFS White | HFS Black | B–W   |
|----------------|--------------|----------|----------|------|-----------|-----------|-------|-----------|-----------|-------|
| (A) K to 3rd  | FI $[N_w = 214, N_b = 77]$ | 0.266 (0.050) | 0.385 (0.069) | 0.118 (0.094) | 0.106 (0.030) | 0.666 (0.035) | −0.040 (0.043) | 0.628 (0.060) | 0.550 (0.074) | −0.078 (0.101) |
|                | MFS $[N_w = 233, N_b = 85]$ | 0.137 (0.031) | 0.156 (0.059) | 0.019 (0.066) | 0.090 (0.024) | 0.201 (0.058) | 0.110° (0.063) | 0.773 (0.035) | 0.644 (0.071) | −0.1289 (0.080) |
|                | HFS $[N_w = 4,523, N_b = 480]$ | 0.024 (0.004) | 0.086 (0.025) | 0.062° (0.026) | 0.035 (0.005) | 0.131 (0.032) | 0.095° (0.032) | 0.941 (0.006) | 0.783 (0.043) | −0.158° (0.044) |
| (B) 3rd–5th   | FI $[N_w = 177, N_b = 72]$ | 0.526 (0.074) | 0.650 (0.073) | 0.124 (0.098) | 0.186 (0.041) | 0.136 (0.062) | −0.051 (0.069) | 0.288 (0.064) | 0.215 (0.077) | −0.073 (0.096) |
|                | MFS $[N_w = 171, N_b = 78]$ | 0.201 (0.048) | 0.141 (0.056) | −0.060 (0.075) | 0.155 (0.043) | 0.198 (0.051) | 0.044 (0.068) | 0.645 (0.060) | 0.661 (0.063) | 0.016 (0.082) |
|                | HFS $[N_w = 4,622, N_b = 492]$ | 0.032 (0.005) | 0.082 (0.021) | 0.050° (0.021) | 0.029 (0.005) | 0.114 (0.028) | 0.084° (0.030) | 0.939 (0.006) | 0.805 (0.029) | −0.134° (0.031) |
| (C) 5th–8th   | FI $[N_w = 227, N_b = 90]$ | 0.515 (0.042) | 0.482 (0.068) | −0.033 (0.082) | 0.067 (0.011) | 0.185 (0.054) | 0.118° (0.055) | 0.418 (0.045) | 0.333 (0.061) | −0.085 (0.074) |
|                | MFS $[N_w = 184, N_b = 81]$ | 0.265 (0.061) | 0.166 (0.062) | −0.099 (0.098) | 0.097 (0.028) | 0.237 (0.066) | 0.140° (0.071) | 0.638 (0.063) | 0.597 (0.086) | −0.041 (0.123) |
|                | HFS $[N_w = 4,559, N_b = 471]$ | 0.030 (0.005) | 0.089 (0.018) | 0.059° (0.018) | 0.041 (0.006) | 0.151 (0.029) | 0.110° (0.027) | 0.929 (0.008) | 0.760 (0.035) | −0.169° (0.032) |
| (D) K to 8th  | FI $[N_w = 214, N_b = 77]$ | 0.361 (0.052) | 0.443 (0.101) | 0.082 (0.113) | 0.172 (0.038) | 0.265 (0.079) | 0.092 (0.089) | 0.467 (0.058) | 0.292 (0.077) | −0.174° (0.093) |
|                | MFS $[N_w = 233, N_b = 85]$ | 0.270 (0.049) | 0.153 (0.044) | −0.118° (0.064) | 0.048 (0.012) | 0.305 (0.072) | 0.257° (0.074) | 0.682 (0.051) | 0.542 (0.070) | −0.139 (0.090) |
|                | HFS $[N_w = 4,523, N_b = 480]$ | 0.037 (0.005) | 0.119 (0.020) | 0.082° (0.021) | 0.037 (0.006) | 0.133 (0.028) | 0.096° (0.027) | 0.926 (0.007) | 0.748 (0.035) | −0.178° (0.035) |

**Notes:** See text for description of the estimator. Balanced panels were constructed using the second, fifth, sixth, and seventh wave of the data; appropriate longitudinal weights were used in the estimation. Paired jackknife (JK2) standard errors are in parentheses; only B–W differences in transition probabilities annotated for statistical significance.

- FI food insecure, MFS marginal food secure, HFS high food secure.
- $^a p < 0.10$
- $^b p < 0.05$
- $^c p < 0.01$
Finally, we focus on the upper end of the food security distribution and estimate the probability of a household remaining in a state of high food security over time. We find that for all panels, the estimated differences in the probability of remaining classified as high food secure, between black and white households, are negative and statistically significant. This would suggest that white households, relative to black households, have a greater probability of remaining entrenched in a state of high food security in some terminal period conditional of being classified as high food secure in some initial period. The differences in staying probabilities associated with high food security range from $-0.13$ to $-0.18$, implying that black households, relative to white households, are anywhere from 13 to 18 percentage points less likely to remain in a state of high food security once achieving such status. Further, these estimated differences are all statistically significant at conventional levels.

Thus, the estimated transition dynamics above would suggest that black households are disadvantaged, relative to white households, in the extremes of the food security distribution. Meaning, black households seem to have a higher probability of getting “stuck” in a state of food insecurity over time while at the same time appear to revert out of a state of high food security once achieving such a state.

### 5.1.2 Black–white directional transition probabilities

Turning attention to directional movements, either up or down, through the distribution of food security, the following results stand out. First, conditional on being food insecure in the initial period, black households, compared to white households, have a much lower probability of traversing upward through the distribution of food security to such an extent of being classified as high food secure in the terminal period. For example, between kindergarten and third grade, black households have an estimated 8 percentage point lower probability of becoming high food secure in the terminal period conditional on being classified as food insecure in the initial period. The magnitude of the estimated gap in mobility is similar for transitions between third and fifth grade, and fifth and eighth grade. However, none of these estimated gaps are statistically significant at conventional levels. Looking over the longest horizon of time from kindergarten to eighth grade, the gap in estimated mobilities becomes strikingly large. Specifically, black households have an estimated 29% likelihood of becoming high food secure in the terminal period conditional on being classified as food insecure in the initial period, whereas the corresponding estimate for white households is 47%. The estimated mobilities, then, result in a black–white gap in the upward transition from food insecure to high food secure of 17 percentage points with the estimated gap being statistically significant at conventional levels.

Second, conditional on being classified as high food secure in the initial period, black households, relative to white households, always have a higher probability of being classified as food insecure in the terminal period. Averaged over all horizons of time, black households are approximately 6 percentage points more likely to slide down through the distribution of food security, and subsequently classified as food insecure, even when initially classified as high food secure.
In sum, white households (black households) seem to be significantly more upwardly (downwardly) mobile relative to black households (white households) in the food security distribution.

5.2 Hispanic–white mobility gap

In Table 3 we present the transition dynamics for white and Hispanic households, as well as the estimated differences in transition probabilities between the two racial groups. As in Table 2, we estimate the transition probabilities for food security between kindergarten and third grade (panel (A)), third and fifth grade (panel (B)), fifth and eighth grade (panel (C)), and finally kindergarten and eighth grade (panel (D)).

5.2.1 Hispanic–white staying probabilities

As before, we begin our discussion focusing on the estimated staying probabilities, but now in the context of white and Hispanic households. What immediately surfaces is that we find mixed results when focusing on staying probabilities at the low end of the food security distribution. In particular, we find that between kindergarten and third grade, and third grade and fifth grade, Hispanic households, conditional on being food insecure in the initial period, have a higher probability of remaining food insecure over time compared to white households. However, the estimated staying probabilities from fifth to eighth grade, and from kindergarten to eighth grade, suggest that white households are more likely to become “stuck” in the lower end of the food security distribution relative to Hispanic households. For example, between fifth and eighth grade, white households have an approximate 20 percentage point higher probability, compared to Hispanic households, of remaining in a state of food insecurity, while the corresponding figure between kindergarten and eighth grade is approximately 14 percentage points. Both of these estimated gaps in mobility are statistically significant at conventional levels. Note, this level of ambiguity is in contrast to the estimated gaps in staying probabilities between white and black households at the lower end of the food security distribution where the estimated staying probabilities, when statistically significant, suggest that black households have a higher probability of being entrenched in a poor state of food security over time.

Looking at the estimated staying probabilities associated with marginal food security we find that Hispanic households almost always have a higher probability of staying marginally food secure relative to white households. For example, between kindergarten and third grade, third and fifth grade, and kindergarten and eighth grade, the probability of staying marginally food secure is higher for Hispanic households, compared to white households, by approximate magnitudes of 3 percentage points, 11 percentage points, and 5 percentage points, respectively. The one exception is when looking from fifth to eighth grade. Over this period of time, white households seem to have a higher likelihood of remaining marginally food secure compared to Hispanic households. However, the estimated gap in the staying probability is small (around 3 percentage points) and not statistically significant at conventional levels.

Turning attention to the estimated staying probabilities associated with high food security, it becomes immediately clear that, across all time periods, the estimated probabilities of white households remaining high food secure over time is greater
| Panel       | Period $t_0$ | Period $t_1$ | FI White | Hispanic | H-F | MFS White | Hispanic | H-F | HFS White | Hispanic | H-F |
|-------------|--------------|--------------|----------|----------|-----|----------|----------|-----|-----------|----------|-----|
| (A) K to 3rd | FI $[N_w = 214, N_h = 180]$ | 0.266 (0.050) | 0.375 (0.042) | 0.108* (0.064) | 0.106 (0.030) | 0.114 (0.023) | 0.008 (0.035) | 0.628 (0.060) | 0.511 (0.045) | −0.116 (0.073) |
|             | MFS $[N_w = 233, N_h = 128]$ | 0.137 (0.031) | 0.184 (0.032) | 0.047 (0.045) | 0.090 (0.024) | 0.119 (0.034) | 0.028 (0.041) | 0.773 (0.035) | 0.697 (0.044) | −0.0757 (0.056) |
|             | HFS $[N_w = 4523, N_h = 902]$ | 0.024 (0.004) | 0.046 (0.009) | 0.022b (0.010) | 0.035 (0.005) | 0.094 (0.017) | 0.059c (0.017) | 0.941 (0.006) | 0.860 (0.017) | −0.081c (0.019) |
| (B) 3rd-5th | FI $[N_w = 177, N_h = 132]$ | 0.526 (0.074) | 0.538 (0.057) | 0.012 (0.092) | 0.186 (0.041) | 0.153 (0.045) | −0.033 (0.060) | 0.288 (0.064) | 0.309 (0.061) | 0.021 (0.085) |
|             | MFS $[N_w = 171, N_h = 97]$ | 0.201 (0.048) | 0.230 (0.056) | 0.029 (0.074) | 0.155 (0.043) | 0.265 (0.078) | 0.110 (0.091) | 0.645 (0.060) | 0.505 (0.081) | −0.140 (0.110) |
|             | HFS $[N_w = 4622, N_h = 981]$ | 0.032 (0.005) | 0.103 (0.012) | 0.071c (0.013) | 0.029 (0.005) | 0.066 (0.010) | 0.036c (0.012) | 0.939 (0.006) | 0.831 (0.017) | −0.107c (0.019) |
| (C) 5th-8th | FI $[N_w = 227, N_h = 196]$ | 0.515 (0.042) | 0.319 (0.054) | −0.196c (0.069) | 0.067 (0.011) | 0.156 (0.036) | 0.089b (0.040) | 0.418 (0.045) | 0.525 (0.068) | 0.107 (0.083) |
|             | MFS $[N_w = 184, N_h = 104]$ | 0.265 (0.061) | 0.248 (0.066) | −0.016 (0.087) | 0.097 (0.028) | 0.072 (0.030) | −0.025 (0.041) | 0.638 (0.063) | 0.679 (0.065) | 0.041 (0.095) |
|             | HFS $[N_w = 4559, N_h = 910]$ | 0.030 (0.005) | 0.051 (0.009) | 0.021b (0.010) | 0.041 (0.006) | 0.052 (0.009) | 0.011 (0.011) | 0.929 (0.008) | 0.897 (0.014) | −0.032a (0.016) |
| (D) K to 8th | FI $[N_w = 214, N_h = 180]$ | 0.361 (0.052) | 0.224 (0.047) | −0.137c (0.069) | 0.172 (0.038) | 0.120 (0.030) | −0.052 (0.046) | 0.467 (0.058) | 0.656 (0.051) | 0.189b (0.076) |
|             | MFS $[N_w = 233, N_h = 128]$ | 0.270 (0.049) | 0.243 (0.040) | −0.028 (0.065) | 0.048 (0.012) | 0.101 (0.023) | 0.053 (0.028) | 0.682 (0.051) | 0.656 (0.049) | −0.025 (0.074) |
|             | HFS $[N_w = 4523, N_h = 902]$ | 0.037 (0.005) | 0.073 (0.011) | 0.036c (0.012) | 0.037 (0.006) | 0.057 (0.010) | 0.020 (0.012) | 0.926 (0.007) | 0.870 (0.012) | −0.056c (0.014) |

Notes: See text for description of the estimator. Balanced panels were constructed using the second, fifth, sixth, and seventh wave of the data; appropriate longitudinal weights were used in the estimation. Paired jackknife (JK2) standard errors are in parentheses; only H-W differences in transition probabilities annotated for statistical significance.

*FI food insecure, MFS marginal food secure, HFS high food secure*

\(^a p < 0.10\)

\(^b p < 0.05\)

\(^c p < 0.01\)
compared to Hispanic households. However, even though statistically significant at conventional levels, the Hispanic–white gaps in the probability of remaining high food secure over time are much smaller, in absolute value, compared to the estimated gaps in the likelihood of remaining high food secure between black and white households. For example, between kindergarten and eighth grade, white households have almost a 6 percentage point higher probability of staying high food secure relative to Hispanic households. At the same time, and as can be seen in Table 2, the black–white gap in remaining high food secure is, on average, 16 percentage points. In other words, the black–white gap in the probability of remaining high food secure over time is, on average, more than two times the Hispanic–white gap.

Summarizing the findings thus far, both Hispanic and black households, relative to white households, are disadvantaged in terms of distributional mobility at the extremes of the food security distribution. Both minority groups have higher likelihoods of remaining food insecure over time while at the same time have lower probabilities of remaining high food secure once achieving such status. However, the results for Hispanic–white differences in remaining food insecure over time are mixed. Further, the estimated gaps in staying probabilities in the extremes of the food security distribution are less prominent for Hispanic relative to white households compared to the estimated gaps between black and white households over the same time periods.

5.2.2 Hispanic–white directional transition probabilities

Noteworthy results also emerge when looking at directional movements through the food security distribution between Hispanic and white households. First, conditional on being classified as food insecure in the initial period, results are mixed with respect to the likelihood of Hispanics being classified as high food secure in the terminal period relative to white households. For example, between kindergarten and third grade, Hispanic households have a 12 percentage point lower probability of becoming high food secure over time relative to white households conditional on being initially classified as food insecure. However, between kindergarten and eighth grade, the underlying distributional mobility between Hispanic and white households is reversed. Relative to white households, Hispanic households now have approximately a 19 percentage point higher probability of transitioning out of a food insecure state and into being classified as high food secure. This is strikingly different compared to what we found between black and white households over the same time period. Looking at the corresponding figure to assess the black-white gap in upward mobility, we find that black households, unlike the Hispanic households, had a 17 percentage point lower probability of transitioning from a state of food insecurity and into a state of high food security over the same time period.

Second, conditional on being classified as high food secure in the initial period, Hispanic households generally have a higher probability of falling down through the distribution of food insecurity relative to white households. Averaged over all time periods, Hispanic households have approximately a 4 percentage point higher probability of being classified as food insecure in the terminal period conditional on initially being classified as high food secure. Further, the estimated differences are statistically significant at conventional levels. However, and similar to earlier
findings, the Hispanic–white gap in downward mobility is less severe relative to the estimated black–white gap in downward mobility.

5.3 Hispanic–black mobility gap

For the sake of completeness, we present the transition dynamics for Hispanic and black households, as well as the estimated differences in transition probabilities between the two racial groups, together in Table 4. As in Tables 2 and 3, we report the transition probabilities for food security between kindergarten and third grade (panel (A)), third and fifth grade (panel (B)), fifth and eighth grade (panel (C)), and finally kindergarten and eighth grade (panel (D)). Other than the estimated gap between Hispanic and black households, there is no new information presented in Table 4 that has not been previously discussed. As such, we keep the discussion brief and primarily focus on the estimated gap in food security mobility between black and Hispanic households.

5.3.1 Hispanic–black staying transition probabilities

Exploring the gaps in transition dynamics between black and Hispanic households reveal estimates that are qualitatively similar to those observed between black and white households. With respect to the gaps in staying probabilities, there are two notable exceptions. First, when looking at the estimated gap in likelihood of remaining food insecure over the time period of kindergarten to eighth grade, the estimated staying probabilities for black households is approximately 8 percentage points higher relative to white households. The same measure when looking at black households relative to Hispanic households yields an estimated gap in the probability of remaining food insecure of approximately 22 percentage points. Thus, black households, relative to Hispanic households, have a 22 percentage point higher probability of remaining food insecure over the time period of kindergarten to eighth grade. This estimated gap is statistically significant at conventional levels and is nearly three times that of the estimated gap in the probability of remaining food insecure when comparing black and white households.

Second, conditional on being classified as high food secure in the initial period, black households have a 9 percentage point higher likelihood, when averaged across all time periods, of falling out of a state of high food security relative to Hispanic households. This same figure for blacks relative to whites, again averaged over all time periods, suggests that black households have a 16 percentage point higher likelihood of not remaining high food secure over time.

Taking into account the mobility dynamics presented thus far together with the two exceptions noted above suggests that black households are at a disadvantage relative to both white and Hispanic households with respect to becoming entrenched in a state of food insecurity and falling out of a state of high food security after reaching such status.

With that said, the magnitude of the gaps in staying probabilities are not as large between black and Hispanic households at the upper extreme of the food security distribution compared to the same gap between black and white households. Nonetheless, the size of the gaps in staying probabilities are, on average, even larger between black and Hispanic households when evaluating the probability of
### Table 4: Estimated transition matrices, Hispanic and black household dynamics

| Panel | Period $t_0$ | Period $t_1$ | FI Black | Hispanic | B–H | MFS Black | Hispanic | B–H | HFS Black | Hispanic | B–H |
|-------|--------------|--------------|----------|----------|-----|----------|----------|-----|----------|----------|-----|
| (A)  | K to 3rd     | FI $[N_h = 180, N_b = 77]$ | 0.385 (0.069) | 0.375 (0.042) | 0.010 (0.077) | 0.066 (0.035) | 0.114 (0.023) | −0.048 (0.042) | 0.550 (0.074) | 0.511 (0.045) | 0.038 (0.086) |
|       | MFS $[N_h = 128, N_b = 85]$ | 0.156 (0.059) | 0.184 (0.032) | −0.029 (0.068) | 0.201 (0.058) | 0.119 (0.034) | 0.082 (0.060) | 0.644 (0.071) | 0.697 (0.044) | −0.053 (0.077) |
|       | HFS $[N_h = 902, N_b = 480]$ | 0.086 (0.025) | 0.046 (0.009) | 0.040 (0.027) | 0.131 (0.032) | 0.094 (0.017) | 0.037 (0.035) | 0.783 (0.043) | 0.860 (0.017) | −0.077 (0.045) |
| (B)  | 3rd–5th      | FI $[N_h = 132, N_b = 72]$ | 0.650 (0.073) | 0.538 (0.057) | 0.112 (0.100) | 0.136 (0.062) | 0.153 (0.045) | −0.018 (0.073) | 0.215 (0.077) | 0.309 (0.061) | −0.094 (0.101) |
|       | MFS $[N_h = 97, N_b = 78]$ | 0.141 (0.056) | 0.230 (0.056) | −0.089 (0.076) | 0.198 (0.051) | 0.265 (0.078) | −0.066 (0.099) | 0.661 (0.063) | 0.505 (0.081) | 0.156 (0.107) |
|       | HFS $[N_h = 981, N_b = 492]$ | 0.082 (0.021) | 0.103 (0.012) | −0.021 (0.023) | 0.114 (0.028) | 0.066 (0.010) | 0.048 (0.030) | 0.805 (0.029) | 0.831 (0.017) | −0.027 (0.034) |
| (C)  | 5th–8th      | FI $[N_h = 196, N_b = 90]$ | 0.482 (0.068) | 0.319 (0.054) | 0.163$^a$ (0.089) | 0.185 (0.054) | 0.156 (0.036) | 0.029 (0.065) | 0.333 (0.061) | 0.525 (0.068) | −0.192$^a$ (0.094) |
|       | MFS $[N_h = 104, N_b = 81]$ | 0.166 (0.062) | 0.248 (0.066) | −0.083 (0.091) | 0.237 (0.066) | 0.072 (0.030) | 0.165$^a$ (0.073) | 0.597 (0.086) | 0.679 (0.065) | −0.082 (0.110) |
|       | HFS $[N_h = 910, N_b = 471]$ | 0.089 (0.018) | 0.051 (0.009) | 0.038$^a$ (0.020) | 0.151 (0.029) | 0.052 (0.009) | 0.099$^a$ (0.030) | 0.760 (0.035) | 0.897 (0.014) | −0.137$^a$ (0.040) |
| (D)  | K to 8th     | FI $[N_h = 180, N_b = 77]$ | 0.443 (0.101) | 0.224 (0.047) | 0.219$^a$ (0.113) | 0.265 (0.079) | 0.120 (0.030) | 0.145$^a$ (0.083) | 0.292 (0.077) | 0.656 (0.051) | −0.363$^a$ (0.095) |
|       | MFS $[N_h = 128, N_b = 85]$ | 0.153 (0.044) | 0.243 (0.040) | −0.090 (0.056) | 0.305 (0.072) | 0.101 (0.023) | 0.204$^a$ (0.075) | 0.542 (0.070) | 0.656 (0.049) | −0.114 (0.090) |
|       | HFS $[N_h = 902, N_b = 480]$ | 0.119 (0.020) | 0.073 (0.011) | 0.048$^b$ (0.021) | 0.133 (0.028) | 0.057 (0.010) | 0.076$^b$ (0.030) | 0.748 (0.035) | 0.870 (0.012) | −0.122$^a$ (0.037) |

**Notes:** See text for description of the estimator. Balanced panels were constructed using the second, fifth, sixth, and seventh wave of the data; appropriate longitudinal weights were used in the estimation. Paired jackknife (JK2) standard errors are in parentheses; only H–B differences in transition probabilities annotated for statistical significance.

*FI* food insecure, *MFS* marginal food secure, *HFS* high food secure

$^a p < 0.10$

$^b p < 0.05$

$^c p < 0.01$
remaining food insecure over time compared to the same gap in the probability of remaining food insecure between black and white households.

5.3.2 Hispanic–black directional transition probabilities

Similar to the estimated gaps in staying probabilities between black and Hispanic households, the overall estimated differences in directional transition probabilities between black and Hispanic households are qualitatively similar to the estimated differences in the same mobility measures between black and white households with black households having lower probabilities of moving upward in food security status and higher probabilities of moving downward in food security status relative to Hispanic households over time.

However, one difference is worth highlighting. Specifically, the estimated gaps in the probability of moving upward out of a state of food insecurity and into a state of high food security are much smaller for black households relative to Hispanic households when compared to black households relative to white households. This is particularly true over the longer run horizon of kindergarten to eighth grade where the estimated gap in moving from a state of food insecurity to a state of high food security is approximately 36 percentage points (in absolute value) when comparing black and Hispanic households. In other words, black households relative to Hispanic households are 36 percentage points less likely to climb out of a state of food insecurity and into a state of high food security over the time period of kindergarten to eighth grade. This same value obtained by comparing black and white households is approximately 17 percentage points.

Taking into account these results, it appears that black households are at a disadvantage, with respect to upward and downward mobility, relative to both white and Hispanic households. These results, taken together with the estimated differences in staying probabilities, suggests that black households are the most vulnerable group when compared to both white and Hispanic households. All results comparing Hispanic to black households can be found in Table 4.

5.4 Implications of the mobility gaps

As documented above, black households and white households appear to be on divergent trajectories of distributional mobility. In particular, black households relative to white households, almost always have a higher probability of staying food insecure while at the same time having a lower probability of remaining high food secure over time. Additionally, black households have a much lower probability of achieving high food secure status when initially being classified as food insecure. Further, black households have a significantly greater chance of reverting into a state of food insecurity when starting from a state of high food security.

Unlike our findings for black households relative to white households, it is more difficult to gauge whether the mobility patterns of Hispanic and white households are divergent over time. While Hispanic households have higher probabilities of remaining food insecure relative to white households, the estimated gaps in staying probabilities (in both the food insecure and high food secure states) between the Hispanic and white households are much less prominent compared to the gaps in
staying probabilities between black and white households. Further, conditional on being classified as food insecure in the initial period, Hispanic households are not always at a disadvantage with respect to the likelihood of achieving high food secure status over time. Finally, although the probability of downward mobility is always higher for the Hispanic households compared to white households, the Hispanic-white gap in downward mobility is significantly smaller compared to the black-white gap in downward mobility. Given the observed transition dynamics between black and white households and between Hispanic and white households, reasonable questions to ask are: what are the long run implications of such mobility patterns, and how different are the mobility patterns of black and white households, and Hispanic and white households? To get at these questions, we derive the Markov chain steady-state distributions based on the transition dynamics estimated using the longest horizon of time of kindergarten to eighth grade. The Markov chain steady-state distributions for black versus white households and Hispanic versus white households can be seen in Figs. 1 and 2, respectively.

After constructing the steady-state distributions, the following patterns emerge. First, looking at Fig. 1, one can see that approximately 88% of white households settle in a state of high food security, while the corresponding figure for black households is approximately 62%. Further, close to 20% of black households settle in the food insecure portion of the food security distribution and another 20% settle in the marginally food secure portion of the food security distribution. In contrast, only 7% and 5% of white households settle in the food insecure and marginally food secure portions of the food security distribution, respectively.

Interestingly, and as can be seen in Fig. 2, the steady-state distribution for Hispanic households is very similar to that of white households. Specifically, approximately 84% of Hispanic households settle in a state of high food security, whereas only 10% and 7% of Hispanic households settle in the food insecure and marginally food secure states of the distribution, respectively. Given the similarities in the long-run transition dynamics of white and Hispanic households, it is not surprising to see that the steady-state distribution of Hispanic households plotted against the steady-state distribution of black households (Fig. 3) appears qualitatively similar to the steady-state distributions of white households plotted against black households (Fig. 1).

![Fig. 1 Markov chain steady-state distributions, black vs. white](image-url)
The above findings related to the steady-state are not something one would expect given the well-documented gaps in food security rates between white and minority households. Taken together, the food security gaps in levels and the gaps in mobility further suggest that the observed disparity in food security rates may be more of a problem for black households relative to both white and Hispanic households. Further, the long run steady-state distributions suggest that the black–white gap in food security is more of a persistent problem whereas the Hispanic–white gap in food security may be more related to the timing of when household-level food security status is measured.

### 5.5 Conditional mobility gaps

Given the differences in mobility patterns highlighted above, we employ a regression framework in an attempt to uncover the observable characteristics that might be associated with these differences. Ideally, we would hope to employ a strategy aimed at identifying causality, but given obvious difficulty in doing such we opt for a more descriptive approach. With that said, we explore whether particular observables that
one may think are associated with food security can attenuate the gaps in mobility between black and white households and between Hispanic and white households. To do this we estimate a linear probability model and decompose the impact of various observable measures on the unconditional gaps in mobility. Further, we do this for both upward transition probabilities conditional on initially being classified as food insecure, and for downward transition probabilities conditional on initially being classified as high food secure. In short, we want to focus on the extremes of the food security distribution and see what characteristics can help explain why certain groups are able to move out of a state of food insecurity as well as why certain groups tend not to remain in a high state of food security once there.

Specifically, we estimate

$$y_{it} = \alpha + \gamma_1 B_i + \gamma_2 H_i + x_{it} \beta + \lambda_t + \varepsilon_{it}$$  \hspace{1cm} (4)$$

where $y_{it}$ is equal to 1 if a household moves upward out of a state of food insecurity between $t_0$ and $t_1$ (when estimating upward transition probabilities) or $y_{it}$ is equal to 1 if a household moves downward out of a state of high food security between $t_0$ and $t_1$ (when estimating downward transition probabilities), $B_i$ and $H_i$ are black and Hispanic indicator variables, respectively, $x_{it}$ is a vector of covariates, $\lambda_t$ is a complete set of time fixed effects, and $\varepsilon_{it}$ is a normally distributed, well-behaved error term. We estimate (4) multiple times for both upward and downward transition dynamics. For the base cases, we fix $\beta$ and $\lambda_t$ equal to zero. The coefficient estimates on $B_i$ and $H_i$ can then be interpreted as the unconditional gaps in distributional mobility between whites and blacks and whites and Hispanics, respectively. In a sequential manner, we then introduce observables and time fixed effects into the model. Since $\gamma_1$ and $\gamma_2$ capture the average difference in distributional mobility between white and black households and white and Hispanic households, respectively, any estimated statistical differences in these coefficients across model specifications may suggest that observable characteristics and/or time fixed effects play a role in influencing the black-white and Hispanic-white gaps in mobility. The particular covariates used in estimating the conditional mobility gaps include socioeconomic status (SES) and its square.\textsuperscript{9} Estimates for the black-white and Hispanic-white gaps in mobility, as well as the estimated changes in the gaps across model specifications, can be found in Table 5.

First focusing on upward transition probabilities out of the bottom of the food security distribution for black households relative to white households, we can see that moving from column (1) to column (3), each time adding measures of SES and/or time fixed effects, effectively attenuates the gap, on average, between black and white households. Specifically, in column (1) the point estimate of $-0.075$ is interpreted as black households, on average, being 7.5 percentage points less likely to move upward and out of the bottom of the food security distribution compared to white households when initially starting out in a state of food insecurity. However, after controlling for SES and time fixed effects, this point estimate becomes less negative at $-0.021$.

\textsuperscript{9} This singular measure of SES is composed of many potential observables related to the divergent gaps in food security dynamics. In particular, the measures that the National Center for Education Statistics (NCES) uses to construct this measure of SES include father/male guardian’s education, mother/female guardian’s education, father/male guardian’s occupational prestige, mother/female guardian’s occupational prestige, and household income. See https://nces.ed.gov/ecls/data/ECLSK_K8_Manual_part2.pdf Last Accessed: March 21, 2019.
Table 5 Influence of observables on the B–W and H–W gaps in directional transition dynamics

|                | Upward transition probabilities |                      | Downward transition probabilities |                      |
|----------------|--------------------------------|----------------------|-----------------------------------|----------------------|
|                | (1)                            | (2)                  | (3)                              | (4)                  |
|                | PP change (1) to (3)            |                      | PP change (4) to (6)              |                      |
| Black          | −0.075 (0.063)                 | −0.033 (0.065)       | −0.021 (0.061)                   | 0.055c (0.020)       |
| Hispanic       | 0.035 (0.050)                  | 0.095a (0.049)       | 0.095b (0.048)                   | 0.060c (0.015)       |
| SES            | –                              | 0.144c (0.035)       | 0.157c (0.038)                   | –                    |
| SES2           | –                              | 0.009 (0.026)        | 0.018 (0.027)                    | –                    |
| Time FE        | No                             | Yes                  | –                                | No                   |
| N              | 1,304                          | 1,304                | 1,304                            | 17,515               |

Notes: Estimates for the upward transition dynamics are conditional on being food insecure in time \( t_0 \); estimates for the downward transition dynamics are conditional on being high food secure in time \( t_0 \). Appropriate survey design weights were used to estimate standard errors (in parentheses); see text for more details.

SES socioeconomic status, FE fixed effects, PP percentage points, N number of observations

*p < 0.10

*b p < 0.05

*c p < 0.01
Although these point estimates are statistically insignificant, the change in these point estimates of 5.5 percentage points is statistically significant at $\alpha = 0.01$.

For Hispanic households, sequentially adding covariates and time fixed effects increases the mobility gap associated with moving out of the bottom of the food security distribution from 3.5 percentage points in favor of Hispanics relative to whites (column (1)) to 9.5 percentage points (column (3)). This 6 percentage point change in the average probability of traversing upward out of a state of food insecurity for Hispanic households compared to white households is statistically significant at $\alpha = 0.01$.

Turning attention to movements downward out of the top of the food security distribution (columns (4) through (6)), we can see that for black households there is again a statistically significant attenuation towards zero in the mobility gap. Interpreting the coefficient estimate for black households in column (4) suggests that black households, relative to white households, have, on average, a 15.3 percentage point greater probability of falling out of a state of high food security compared to white households conditional on starting out in a state of high food security. Controlling for SES and time fixed effects attenuates this gap by 5.9 percentage points, or 38%, with this change being statistically significant at $\alpha = 0.01$. However, even after adding relevant controls and time fixed effects, the black–white gap in the probability of falling out of the top of the food security distribution still persists at 9.5 percentage points (column (6)). For Hispanics, we also observe a statistically significant reduction, on average, in the downward mobility gap between Hispanic and white households from 7.4 percentage points to 1.4 percentage points with this 6 percentage point reduction in the Hispanic–white gap being statistically significant at $\alpha = 0.01$.

In summary, it appears that in most cases SES and time fixed effects are meaningfully associated with reducing the gap in both upward and downward transition probabilities between black and white households and in reducing downward transition probabilities between Hispanic and white households. In particular, if we were to assign black households with children entering kindergarten the mean value of SES of white households, and assume that the relationship between upward mobility and SES are in fact causal, then the gap in upward mobility between white and black households would be attenuated by approximately 9 percentage points. With respect to the gap in upward transition probabilities between Hispanic and white households, the gap actually widens in favor of Hispanic households once controlling for SES and time fixed effects. If we were to perform the same exercise as we did for black households and assign Hispanic households with children in kindergarten the mean value of SES of white households, and assume a causal relationship, then the gap in upward mobility between white and black households, by approximately 9 percentage points. The gap in downward transition probabilities are attenuated for both black and Hispanic households when controlling for SES and time fixed effects. In particular, if we were to again assign the mean level of SES of white households to both Hispanic and black households, and again assume a causal relationship, then the gap in downward probabilities would decrease by approximately 6 percentage points for both Hispanic and black households.

Finally, we find further evidence that the differences in upward and downward transition probabilities favor Hispanic households relative to black households. Across all model specifications in Table 5, the coefficient estimates on the black and Hispanic indicators are statistically different from each other at conventional levels. This, perhaps,
is further suggestive of black households being the most vulnerable group, relative to white and Hispanic households, even after conditioning on socioeconomic status.

### 6 Conclusion

Household-level food insecurity is a considerable public health concern faced by millions of individuals in the United States today. Further, the proportion of households with children that are food insecure is not homogenous across racial lines. In particular, there is a well-documented gap in the rates of food insecurity between non-Hispanic white and minority households with the proportion of non-Hispanic white households classified as food insecure being less than both Hispanic and non-Hispanic black households. With that said, very scant attention has been paid to understanding how various racial groups traverse through the distribution of food security over time. Understanding how various groups move through the food security distribution is necessary in understanding the severity of these documented level-gaps in the rates of food security. Meaning, are the mobility dynamics of the various groups equally high suggesting that the long run distributions of food security will normalize across the various groups? Or, are the mobility patterns divergent in such a way that we would expect a higher proportion of minority households settling at the bottom of the food security distribution while a higher proportion of non-Hispanic white households settling towards the top of the food security distribution? These are the questions posed here.

Our results suggest that Hispanic and non-Hispanic white households with children are equally mobile in the long run whereas non-Hispanic black households with children tend to both get “stuck” in the low end of the food security distribution and transition out of the top end of the distribution after having achieved high food security status. In the long run, then, rates of food insecurity between Hispanic and non-Hispanic white households with children would tend to converge as an equal proportion of non-Hispanic white and Hispanic households stabilize across the food security distribution. However, convergence in food security rates between non-Hispanic black and non-Hispanic white households with children is unlikely unless policy-makers can figure out how to keep at-risk, non-Hispanic black households out of a state of food insecurity while at the same time keeping non-Hispanic black households in a state of high food security once such status is achieved. Further, the results tend to suggest that non-Hispanic black households with children are the most vulnerable group when compared to both non-Hispanic white and Hispanic households with children, even after controlling for socioeconomic status. This revealing contribution to the literature can, perhaps, inform policy-makers that moving various groups out of a state of food insecurity while at the same time keeping households in some state of food security may require policy that is well-targeted and group specific. A note of caution is needed. The results presented here are not intended to reveal causal determinants of the differential in food security dynamics between non-Hispanic white and minority households. Although we reveal associations between socioeconomic status and the gaps in upward and downward mobility measures, further work is needed to establish a causal relationship. Understanding the causal determinants of such mobility patterns is a natural next step in building off our results presented here.
As with only focusing on the level gap in food security rates between non-Hispanic white and minority households with children, focusing solely on the underlying mobility dynamics associated with food security would be equally incomplete as evaluating the level gaps in food security rates alone. It is both the gaps in levels and the gaps in mobility dynamics that provide policy-makers with the insight needed to craft effective, well-targeted policy aimed at mitigating food insecurity for all households.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interests.

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7 Appendix

Table 6

| Table 6 | Core food security module (CFSM) |
|---------|----------------------------------|
| 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. “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? |
| 5. 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) |
| 6. “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? |
| 7. 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) |
| 8. (If yes to Question 5) How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months? |
| 9. “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? |
| 10. In the last 12 months, were you ever hungry, but didn’t eat, because you couldn’t afford enough food? (Yes/No) |
| 11. In the last 12 months, did you lose weight because you didn’t have enough money for food? (Yes/No) |
| 12. 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) |
| 13. 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) |
| 14. In the last 12 months, were the children ever hungry but you just couldn’t afford more food? (Yes/No) (If yes to Question 13) How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months? |
| 15. In the last 12 months, did any of the children ever skip a meal because there wasn’t enough money for 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) |

Note: Responses in bold are “affirmative”. Table taken from Kuku et al. (2012)
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