Economic Inequality and Stratification after a Natural Disaster: Evidence from Joplin

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Abstract:
Using illustrative data from the American Community Survey (ACS), we present a case study linking the economics of disasters to stratification economics in this paper. The case study is drawn from the experience surrounding the large tornado event in Joplin, Missouri in 2011. Tying to the tenets of stratification economics, the models reflect both own and relative group positions. This shows how growing inequalities after a disaster may be viewed as related to social stratification dynamics of the sort described in the burgeoning stratification economics subfield.

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INTRODUCTION

Climate scientists predict increasing frequencies and magnitudes of significant weather events, including tornadoes which are particularly economically costly in terms of both property and infrastructure damage and lives lost (Elsner, 2015). Disaster events can be viewed as abrupt, exogenous shocks to communities that impact economic and social outcomes. Impacts, however, are not necessarily uniform within communities. Instead, differences in vulnerabilities and their consequences can be a function of socioeconomic characteristics in ways that are policy relevant.

While disasters themselves do not discriminate in terms of the place and timing of an event, disaster impacts have been shown to vary by race and ethnicity substantially and systematically (e.g., Fothergill, 1999) for an early summary of literature; Bolin and Kurtz (2017) for a more recent summary). Recent work even coins the term "disaster racism" as an alternative to descriptions of "social vulnerabilities" to acknowledge systemic racism and historical processes more explicitly into the impacts of disasters (Breem, 2021).

The economics of disasters as a field largely has been concerned with impacts on aggregate, community-level outcomes (e.g., assets, infrastructure, local GDP, etc.) (e.g., Kellenberg and Mobarak, 2011; Botzen et al., 2019). These impact measures and others are also at the forefront of work on disaster management by major policy agencies. The National Institute of Standards and Technology (NIST), for example, models natural catastrophes as part of its research program designed to inform codes and standards that can impact health and safety in disaster instances (McAllister, 2015). NIST measures community-level disaster resilience using population, economic, social services, physical services and governance stability goals linked to community characteristics. Within the economic stability core focus area, NIST researchers include income inequality (in addition to absolute income levels themselves), though some of this work is incomplete and ongoing.

The growing subfield of stratification economics within the economics discipline purports that relative group position and intergroup differences are economically meaningful in ways not captured by traditional modeling (e.g., Darity, 2005; Darity et al., 2015; Darity, 2022). Economic wellbeing then is a function of levels of resources as in traditional approaches but also is a function of where one stands in a broader distribution. Following from this perspective, individuals are envisioned to maximize wellbeing by acquiring and consuming resources but also by adopting strategies to maintain or grow their distributional position. The resulting steady state after the realization of these incentives can be viewed as an (unequal and discriminatory) equilibrium of sorts.

Using illustrative data from the American Community Survey (ACS), we present a case study linking the economics of disasters to stratification economics in this paper. The case study is drawn from the experience surrounding the large tornado event in Joplin, Missouri in 2011. Representative micro data is used to examine distributional outcomes of individuals and their public policy-relevant socioeconomic correlates after large disaster events relative to the profiles of communities beforehand. We present (reduced form) models of both the probability of being observed to be below the poverty threshold as an inequality-related economic wellbeing outcome before versus after the tornado for within and outside of Joplin in an exercise stratified by minority versus nonminority demographic groups. Tying to the tenets of stratification economics, the models reflect both own and relative group positions. This shows how growing inequalities after a disaster may be viewed as related to social stratification dynamics of the sort described in the burgeoning stratification economics subfield.

Understanding features of and changes in economic inequality after disasters is relevant to forecasting the magnitude and extent of disaster-induced disruptions to communities' systems and also is relevant to the fine-tuning of community resilience concepts that embody capacity to prepare for anticipated hazards, to withstand or adapt to changing conditions, and to recover quickly. Results for Joplin are broadly consistent with community context-specific dependence noted elsewhere in the literature. Beyond this validation, baseline models in this paper contribute to a framework that can be extended to a large range of distributional concepts and to more sophisticated identification methodologies to further continued NIST evaluation. The exercise in this paper initiates this pursuit by illustrating how post-disaster data can be consistent with features of the theories proposed in stratification economics. This contributes to how we think about appropriate theoretical framing in economic studies of disasters when considering heterogeneous populations.

The rest of the paper is organized as follows. The section "Literature and Background" offers summary of representative articles in the economics of disaster and in stratification economics respectively. This is followed by a section on "Data and Estimation Strategy" followed in turn by "Results" and "Discussion and Conclusions."

LITERATURE AND BACKGROUND

Much of the economics literature on tornadoes focuses on accurately calculating damage (e.g., Simmons et al., 2013) and on the cost-benefit analysis of interventions (e.g., Merrell et al., 2015, on tornado shelters; Wang et al., 2021a, on wind retrofits). Other work focuses on times series changes to employment totals and growth (e.g., Ewing et al., 2003; Ewing et al., 2004; Ewing et al., 2009; Ewing et al., 2021). From a theoretical perspective, resilience frameworks focus on community assets that support livelihood (dating back to Chambers and Conway, 1992). More recent research on resiliency and community recovery examines the experiences of infrastructure, industries, and regional economic activity (e.g., Prevatt, 2012; Wang et al., 2021b).

Disaster Discrimination and Tornadoes

Inequalities stemming from the 2011 Tuscaloosa, Alabama tornado are well-studied. Senkbeil et al. (2014), for example, conducted a small sample survey on risk perceptions and their consequences with focus on race and ethnicity. These authors documented that many minority respondents had poor perceptions of tornado risk prior to the event, a feature associated with limited preparation. In a complementary descriptive study, McKinzie (2017) used interviews to compare Joplin and Tuscaloosa recoveries in terms of intersectionality of race, gender, and class. That study linked patterns to histories of inequalities in these communities prior to the disaster events.

In a descriptive study utilizing qualitative methods, Weber and Lichtenstein (2015) described a “stratified” recovery with unevenness in terms of outcomes such as foreclosures across racial and ethnic groups following the 2011 Tuscaloosa, Alabama tornado. These authors documented the absence of net change in local population size but significant compositional changes where neighborhoods become whiter after the tornado event, population patterns consistent with gentrification and re-segregation dynamics. They then connected the Tuscaloosa case to insights from literature on uneven recovery following Hurricane Katrina.

In larger-data quantitative analysis on the other hand, Lim et al. (2017) documented how vulnerabilities to tornado-related risk decrease with human capital and with income and how government investments can serve to mitigate some risks. These authors described risk conceptually as both a function of physically defined natural hazards and as a function of social constructs. They then estimated a series of econometric death count models as functions of county-level income distribution features (the top 10% of the income distribution and the poverty rate) and demographic factors (such as female-headed households, educational attainment, and housing characteristics with particular attention to mobile homes). Findings included how both income and income inequality are critical determinants of tornado-related deaths, as are housing characteristics.

In another paper based in econometric and demographic statistical methodology, Raker (2020) exploited Census block group exposure in a differences-in-differences framework. This author found that severe tornadoes correlate to subsequent compositional changes in population but not to population size overall. Particularly, Raker showed that communities become whiter and wealthier post disaster. These patterns have implications for displacement and gentrification dynamics and are consistent with those of Weber and Lichtenstein (2015).

In addition to these findings regarding population sorting, empirical evidence suggests consumption and expenditure changes across demographic groups in post disaster settings. A recent paper by Paudel (2022), for example, documented significant "energy poverty" disparities between whites and non-whites measured in terms of energy-related expenditures differences following tornado shocks.

Relative Position and Stratification Economics

Stratification economics stresses the importance of relative group position and intergroup gaps as being meaningful in economic decision-making (e.g., Darity, 2005; Darity et al., 2015; Darity, 2022). Economic wellbeing in this view then is a function of levels of resources as in traditional approaches but also is a function of position in a broader distribution. This observation has the implication that group-based stratification is an outcome of self-interest and of a form of (rational but discriminatory) maximizing behavior by those who receive rents related to their inclusion in these favored groups. Stratification economics as a theory envisions individuals as maximizing wellbeing by acquiring and consuming resources, but also from the act of adopting strategies to maintain or grow their distributional position. The resulting steady state after the realization of these incentives can be viewed as an equilibrium characterized by segregation.

Applying insights from stratification economics to the case of a shock from a natural disaster, we envision a community with an existing level of poverty (poor economic wellbeing) before a disaster. We assume starting poverty to be higher for minority individuals and households relative to non-minorities, as this is well-documented statistically and consistent with historical discrimination. As in Lim et al. (2017)'s disaster modeling, we consider the poverty rate to be an indicator reflecting inequality. If the difference between the poverty rate experienced by a minority member of the community and that experienced by a non-minority community member is increasing post disaster, then the community can be hypothesized to be moving toward more economic stratification relative to its initial position. This would be consistent with the "stratified recovery" described by Weber and Lichtenstein (2015).

Cong et al. (2018) link relocation decisions to homeownership and associated place attachment. As relocation is interconnected to the community compositional changes that occur post disaster, relocation and stratification are theoretically linked. We therefore are interested in whether community-level poverty gaps influence individual outcomes at a differential rate following disasters than previous to them. Confirmation of such a hypothesis would be consistent with the tenets of stratification economics and would add a nuance to our understanding of community rebuilding dynamics.

The Case Study: Joplin, May 22, 2011

Joplin is located between Jasper and Newton counties in Missouri. The 2010 U.S. Census estimated the Joplin population at 50,150 making this the fifth-largest metropolitan area for Missouri. NIST summary documentation of the tornado incident indicates:

> The May 22, 2011, Joplin tornado, rated EF–5 on the Enhanced Fujita tornado intensity scale, caused 161 fatalities and more than 1,000 injuries, making it the deadliest single tornado on record in the U.S. since official records were begun in 1950. The damage to the built environment made this the costliest tornado on record as well, with losses approaching $3 billion. The Joplin tornado damaged 553 business structures and nearly 7,500 residential structures; over 3,000 of those residences were heavily damaged or completely destroyed.[1]

The Joplin tornado was considered a "warned" event in that weather forecasts and information dissemination did allow some preparation time. However, the extent of this preparation was limited when the tornado grew at a faster rate than predicted.

DATA AND ESTIMATION STRATEGY

Data are from the American Community Survey (ACS) from 2006 until 2019[2] with a geographic restriction to the state of Missouri. These data are published as the Integrated Public Use Microdata Series (Ruggles et al., 2022). The Joplin metropolitan area is identifiable. The ACS data are observational and cross-sectional (repeated cross section).

We start by summarizing relevant samples of the baseline data and then estimate the probability of individual-level economic outcome variables using linear regression (linear probability models). We focus on the probability of being at or below the poverty threshold and stratify our sample by race for estimations to allow for differential correlations between the Joplin event and poverty status for those

[1] https://www.nist.gov/disaster-failure-studies/joplin-tornado-ncst-investigation
[2] Although the 2020 1-year ACS PUMS file was available at the time of this writing, data collection and quality concerns and the introduction of "experimental weights" due to COVID-19 present limitations that ultimately influenced the decision to end the sample in 2019 for this paper.

who are White and Non-White respectively. We then consider relationships between the identified changes in poverty and inequality and compositional changes of the population, as interrelated relocations and displacements emerge following the tornado event.

Economic Outcomes: Probability of Poverty

We use a difference-in-differences (DID) estimator in both a 2X2 version that assumes before and after time periods and locational treatment groups are equivalent. We then relax the model and estimate a generalized version controlling for time-specific and group-specific unobservable attributes via fixed-effects. The 2X2 and generalized models respectively take the following forms:

$$poverty_{imt} = \beta_1 Joplin_m + \beta_2 AfterT_t + \beta_3 Joplin_m * AfterT_t + \gamma' X_{imt} + \varepsilon_{imt} \quad (1)$$

$$poverty_{imt} = \delta_1 AfterT_t + \delta_2 Joplin_m * AfterT_t + \theta' X_{imt} + \mu_m + \tau_t + \epsilon_{imt} \quad (2)$$

The dependent variable $poverty_{imt}$ represents poverty assignment of observed individual *i* in geography *m* (metropolitan area) and time *t* (year). The variable is by definition scaled for (a function of) family size given family size's mechanical relationship to official poverty thresholds.

The variable $Joplin_m$ is an indicator that equals 1 if the observation is from the Joplin metropolitan area (based on 2013 Census definition) and equals 0 for any other area in the state of Missouri. This variable can be thought of as the observation level "treatment" indicator, though the setting is one of a natural event as opposed to an experimental design.

The variable $AfterT_t$ as a dummy variable that equals 1 if the observation is from a year *t* that is after the tornado event. The interaction $Joplin_m * AfterT_t$ is the DID estimator and $\beta_3(\delta_2)$ is the parameter of interest for equation (1)((2)) respectively.

Although DID identification does not depend on controlling for covariates, we add covariates X_{imt} to improve precision of the DID estimates. The matrix X_{imt} includes a set of basic demographic controls comprised of age and age squared in years, a dummy variable for female, a dummy variable for married, the total number of own children in the respondent's household, a dummy variable for having at least high school education level, and a dummy variable for household ownership of the current residence. Home ownership is included given home ownership's association with wealth building and intergenerational transmission of poverty especially for minorities, as documented in the stratification economics literature (see Darity, 2022 for a recent survey).

μ_m are metro-specific fixed effects. In the generalized specification of equation (2), the indicator for the Joplin area is contained within this set. τ_t are year-specific fixed effects added in the generalized specification. Finally, ε_{imt} and ϵ_{imt} are errors terms for equations (1) and (2) respectively. Standard errors are clustered at the metropolitan area level as per Bertrand, Duflo, Mullainathan (2004) as the tornado "treatment" occurs at this level.

As the literature suggests stratified recovery dynamics and differences in experience by race along diverse margins we run the DID models separately for Non-Hispanic Whites (White) and for all others (Non-White) instead of modeling as triple difference, although the latter also would be possible.

Relative Poverty and Population Composition

After documenting differential poverty pathways for White and Non-White groups in Missouri, we use an empirical data-driven approach to examine the influence of changing *relative* poverty across these groups on decisions to stay or to relocate within this state's context. We model each of the three outcome variables (y_{imt}) of person *i* observed in the ACS sample from time period *t* following an adaptation of the generalized DID framework from the poverty model expressed in equation (2). The population composition models take the following form:

$$y_{imt} = \delta_1 AfterT_t + \delta_2 Joplin_m * After_t + \delta_3 NW/W\_Pov_{mt-1} + \delta_4 NW/W\_Pov_{mt-1} * AfterT_t + \theta' X_{imt} + \mu_m + \tau_t + \epsilon_{imt} \qquad (3)$$

The series of outcomes, denoted y_{imt}, is based on observations of decisions to stay in place or to relocate. The three dependent variables are in turn are an indicator for reporting being in the same home as in the previous year, an indicator for being classified as a within-state mover (i.e., being a newcomer to the area of observation but reporting being elsewhere within the state in the previous year), and an indicator for being an out of state mover (i.e., a newcomer to the area of observation who reported being located in a different state or country in the previous year).

Since we are interested in whether recovery dynamics can be seen as relating to the mechanisms purported in stratification economics, we define NW/W_Pov_{mt-1} as the Non-White to White poverty ratio in area *m* in the previous year (*t-1*). We interpret this variable as an indicator of relative group economic position. We are interested in what happens after the tornado event in terms of determining individual economic well-being (as measured by the probability of being in poverty) and how this relates to group membership as defined by respondents' race/ethnicity. The interaction $NW/W\_Pov_{mt-1} *$

$AfterT_t$ is used to test if higher inequality relates to changes in the outcome variables in significantly different ways in Missouri in the post-Joplin tornado period. In other words, we test whether the post-disaster experience (measured via the individual probability of staying or changing locations) depends on local-level relative economic inequalities in a way that is stratified by race. The reduced-form approach provides an examination of general equilibrium compositional changes of the local population after a disaster. Since the directions and magnitudes of δ_3 and δ_4 are ultimately empirical questions, we can use the models to derive insight into how the White majority (and likewise the Non-White minority) responds to inequality in ways that may represent discriminatory displacement triggered by a natural disaster.

RESULTS

We present summary statistics followed by regression results.

Description of the Sample and Summary Statistics

Summary statistics for all outcome and control variables appear in Table 1 separately for each of three samples. The first sample corresponds to the state of Missouri as a whole. Summary statistics are reported for the data period from 2006 to 2010 (column (1)) and for 2012 to 2019 (column (2)). These dates correspond to the pre- and post- Joplin tornado periods. The year 2011 is excluded given that ACS sampling occurs throughout the year and an inability to determine which observations were collected before and after May within the 2011 year in the public-use data files. Columns (3)-(4) present analogous tabulations for before and after the tornado for the Joplin location subsample. Finally, columns (5)-(6) do the same for the rest of the state of Missouri (excluding the Joplin metropolitan area). All summary statistics (and regression results) utilize person-level weights as provided by the ACS.

From the point of view of summary statistics, we note that the unconditional probability of being at or below the poverty threshold declined after the tornado in Joplin and rises elsewhere in the state. This is suggestive of some extent of displacement (of the poor) and changes in the composition of communities following disaster. The percentage of respondents who reported being new to Joplin (within and from out of state moves) is lower in the post-tornado period. This is consistent with the expected dynamic of fewer newcomers moving into the area than in the pre-disaster period.

While these summary statistics provide a broad overview of before and after comparisons of economic outcome and mobility variables, these tabulations obscure nuances in year-to-year changes during the long community process of recovery. Figure 1 illustrates average poverty for Whites and Non-Whites in Missouri over time. This sample division is based on an indicator for Non-Hispanic White verses all others that is derived from combining race and ethnicity responses from the ACS survey. A racial poverty gap exists in all years with White individuals being significantly less likely to be in poverty. While this gap was relatively constant in the earlier years of the survey, the figure illustrates a breakpoint in 2011. Poverty rates for both groups sharply increased in 2011. This is expected given the magnitude of the disaster damage and both economic and noneconomic loss in addition to broader macroeconomic conditions. Although poverty rates for both White and Non-White Missourians decreased after 2011, the declines are distinguished by changes in the magnitude of the poverty rate gap between racial groups. Changes in the slopes of the two series in the post-event period are suggestive of differential impacts on Whites and Non-Whites that persist well beyond the 2011 date point. The gap between White and Non-White poverty increased after the Joplin tornado and then decreased subsequently.

The poverty patterns in Figure 1 are unconditional summary statistics that do not control for compositional changes in the population following the disaster. Figure 2 provides a across-time depiction of mobility changes by race associated with the 2011 event. The figure plots the fraction of the population, by race, that reported residing in the same home as in the previous year. These "stayers" neither moved locally (e.g., across neighborhoods) nor regionally (within parts of Missouri) nor across state lines. The figure shows that the fraction of Non-White stayers fell with the Joplin tornado event timing and then increased subsequently. In contrast, the fraction of White stayers (to rebuild) remains fairly constant throughout the period. Theses relative patterns are consistent with increases in racial stratification after the Joplin tornado and may also be related to home ownership attributes as in Cong, et. al (2018). Tabulations of homeownership rates in Table 1 show that homeownership fell in Joplin (from 70.4 percent to 68.2 percent) between the two temporal periods, again consistent with the mass destruction of private property in addition to local infrastructure.

Compositionally, the Joplin population post-2011 has an older average age (approximately 38 years old as opposed to 37 in the pre period in Table 1). The Joplin demographic can be characterized by a higher fraction of minority (Non-White) in comparison to non-minority (Non-Hispanic White) in the post-2011 subsample. Notably, the fraction of the population that identifies as Non-Hispanic White decreased more than four percentage points between the before and after tornado samples.

The fraction of the population that identified on the survey as Non-Hispanic Black race was fairly constant across time periods but is notably lower in Joplin in comparison to the rest of the state. In contrast, the fraction of the population that is estimated to be of Hispanic origin is higher in Joplin than elsewhere. This is most substantial after the tornado event when the Joplin Hispanic population increased almost three percent while the Hispanic fraction of the population elsewhere in Missouri increased less than one percent. This difference accounts for the majority of the decrease of the Non-Hispanic White group as a percentage of the population. The Black non-Hispanic portion of the Joplin population remains very low (on the order of one and a half percent) in comparison to almost 12 percent for the rest of the state. Changing population demographics and associated occupational concentrations during rebuilding therefore may be relevant to understanding consequences of a disaster for both inequality and for stratifications that are accentuated during recovery.

Poverty Model Regressions

Linear probability model regressions for the probability of experiencing poverty that correspond to equations (1) and (2) are presented in Table 2. Columns (1)-(3) show the estimation results corresponding to the Non-Hispanic White subsample of Missouri residents from 2006 to 2019. Columns (4)-(6) do the same for the Non-White subsample. Due to sample size consideration associated with the small percentage of Non-Hispanic Black people in Missouri, the Non-White sample is an aggregation of all Non-White sample respondents. The Non-White sample is inclusive of the Hispanic and Non-Hispanic Black categories that appear in the summary statistics in Table 1 and also of all other racial and ethnic categories. For each of these samples, we consider three specifications. We start with the 2X2 DID model from equation (1) but estimate this model first without the inclusion of control variables. Secondly, we estimate the 2X2 model with the inclusion of additional controls to improve the precision of estimates and to examine differences in correlates to poverty by race. The 2X2 models do not include geographic location and survey year fixed effects. Third, we estimate the generalized DID model corresponding to the specification appearing in equation (2) that adds these fixed effects.

The coefficient on the Joplin dummy variable is generally insignificantly different from zero at conventional significance levels. This confirms that all else equal and prior to 2011 Joplin maintained a similar (or possibly slightly higher) poverty profile to the rest of the state of Missouri. This is generally consistent with the absence of pre-trends.

More striking results come from examining the estimated coefficients on both the after 2011 dummy variable and the interaction of that dummy variable with the Joplin indicator. In all three specifications for the determination of poverty for the Non-Hispanic White sample, we document a *positive* and statistically significant coefficient on the after tornado dummy and a *negative* and statistically significant coefficient for DID estimator interaction term. In all three specifications for the Non-White sample, in contrast, we document a *negative* and statistically significant coefficient on the after tornado dummy and

Non-White poverty and a *positive* and statistically significant coefficient for DID estimator interaction term.

Combining coefficients from these linear probability model estimations, we see that White poverty in the state of Missouri is lower after the tornado event (e.g., 0.005-0.034= -0.03 for the generalized model). Non-White poverty also is lower at the state level in the corresponding generalized model and the difference is of higher economic significance (-0.090+0.023= -0.067). These differential impacts are notable and speak to differential groupwise declines in economic wellbeing in the state and for Joplin specifically after the tornado shock. Conclusions regarding individual wellbeing are convoluted, however, if the decline in poverty is due to displacement of the poor as opposed to improvements in economic conditions.

Relative Poverty and Relocation Models

Tables 3 and 4 present variations of the relocation models following equation (3). Models corresponding to the probability of being in the same home as in the previous year appear in Table 3. Models corresponding to the probability of a within state move within the last year and of the probability of moving into Missouri from an out of state location (alternate state or different country) appear in Table 4. For both White and Non-White households, the change in the probability in the post-tornado period of being in the same house for at least the most recent two years is positive though again magnitudes vary with race.

Increases in the relative poverty variable (ratio of Non-White to White poverty in the previous year) correspond to increases in racial economic inequality since higher values of this statistic indicate a widening of the gap between Non-White and White poverty. The relative poverty ratio is lagged one period to match the local economic conditions corresponding to the timing of decision making to stay in a current residence. For the White sample in Table 3 column (2), we see that the average Non-White to White poverty ratio has a statistically significant and positive association with the probability of being in the same home this year as in the last year. The interaction of this variable with the indicator for after the Joplin tornado yields a significant and negative coefficient that is offsetting. This indicates that the probability of being a White “stayer” in a particular community in Missouri was increasing with relative poverty prior to the disaster but decreasing afterwards. This is suggestive of nonlinearities in response to relative poverty. It is possible that high inequality correlates with incentives for White residents to stay in an area, though as inequality lessens White residents are more likely to leave. Coefficients on both the

Non-White to White poverty ratio and its interaction with the post-Joplin tornado period are insignificant at conventional significance levels for the Non-White sample, and point estimates are close to zero.

Table 4 reveals an inverse pattern for within state moves (in comparison to stayers) for the White population in column (2). This provides confirmational insight regarding the decision margin of this tradeoff since variables of interest in the out of state movement models (columns (5)-(6)) contrastingly are statistically and economically insignificant.

DISCUSSION AND CONCLUSIONS

This paper relates to an effort to identify consistent and implementable measures to assist in forecasting the magnitude and extent of disaster-induced disruptions to community systems. The paper is relevant for efforts to model community recovery, measure resiliency, and optimize risk management. Finally, the conceptual framework could be used to expand core metrics for disasters beyond tornadoes and for stability areas beyond the economic-based one considered in this paper. These efforts are particularly notable given that scientific evidence on climate change suggests that tornadoes in the United States will increase in frequency and magnitude (Elsner et al. 2015).

Aside from the examination of resiliency measurement and economic outcomes broadly following a large weather event, which is relevant to the economics of natural disasters, this paper asks if disparities in recovery patterns across racial and ethnic groups which have been documented elsewhere are consistent with theoretical patterns predicted by the field of stratification economics. These observations suggest that more work needs to be done to better understand post-tornado population dynamics and their implications.

The story presented in this paper is that of the Joplin tornado which instantly decreased economic opportunity for both White and Non-White residents. This impact, however, was heterogeneous both in terms of the initial magnitude of changes in the probability of being in poverty but also in terms of the rates of longer-run attachment to the affected geography. The reviewed literature on tornado events, although limited, is suggestive of displacement processes after an event where economically disadvantaged residents are more forcibly mobile and where the more advantaged (often White) population rebuilds as opposed to being relocated. The change in the rate of Non-White residents staying increased post-disaster for the Joplin case, which decreased racial gaps in propensities to stay over time. This confirms the context-specific nature of findings and of their translation into public policy.

Policy prescriptions in the case of Joplin may differ from those for disasters elsewhere since changes to gaps in economic welfare after a natural disaster depend not only on the magnitudes and characteristics of destruction but also on the transferability of particular skills. The extent of transferability of skills to surviving industries in a post-disaster locale may be interrelated with its population diversity (or lack thereof). This reasoning evokes questions such as to what extent communities bring in new people of different demographic profiles post-disaster instead of capitalizing on the skills of the current population by facilitating the transfer of those who lost jobs into new work. This also begs questions such as to what extent a disaster may represent an "opportunity" for various forms of displacement and discrimination. This paper is one step toward disentangling these types of dynamics.

Stratification economics is suggestive of incentives to differentiate to maintain power of one group relative to others. This theoretical framing is relevant if there are group dynamics on racial or ethnic lines that relate to within-group maximization behavior during the recovery period that may impose externalities on other groups. For Joplin, higher Non-White to White poverty (i.e., more economic inequality) bred a higher percentage of the White population staying in their current homes where Whites may benefit from the disparities falling in their favor. The observation that White people prefer to stay in geographies where Whites do relatively better than Blacks in the pre-period is consistent with the tenets of stratification economics. The reversal of this pattern in the after Joplin tornado period may relate to the distribution of housing damage and pre-existent residential sorting by race, among other factors including the possibility of increased incentives to move away when self-beneficial inequality lessens.

The identification assumption of the DID model to establish causality is that the path of poverty outcomes (and relocation respectively) for those in Joplin and elsewhere in the state would not be systematically different in the absence of the tornado event. Identification therefore hinges on control for group and time unobservable characteristics. The estimates presented in this paper do not rule out that group unobservables may remain correlated with covariate regressors. Although descriptive instead of confirmed to be causal, the specifications presented in this paper point to key stratifications warranting continued work both for the Joplin disaster case and beyond.

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Table 1: Summary Statistics, Before and After Joplin Tornado Event (percentages, unless otherwise noted)

	(1)	(2)	(3)	(4)	(5)	(6)
	Missouri-pre	Missouri-post	Joplin-pre	Joplin-post	non-Joplin-pre	non-Joplin-post
At or Below Poverty Threshold	16.7168	17.1572	20.4805	19.0115	16.6038	17.1016
	[37.3127]	[37.7009]	[40.3581]	[39.2405]	[37.2116]	[37.6523]
Same Home	83.0465	84.4115	82.9857	85.7112	83.0484	84.3725
	[37.5224]	[36.2747]	[37.5779]	[34.9971]	[37.5208]	[36.3116]
Within State Move	13.991	12.62	13.8465	11.2168	13.9954	12.662
	[34.6894]	[33.2075]	[34.5406]	[31.5584]	[34.6939]	[33.2547]
From Out of State	2.9625	2.9686	3.1679	3.072	2.9563	2.9655
	[16.955]	[16.9718]	[17.5153]	[17.2563]	[16.9378]	[16.9632]
Age (years)	37.5494	38.8994	36.9751	37.9508	37.5666	38.9278
	[22.9217]	[23.3345]	[23.1615]	[23.3726]	[22.9143]	[23.3328]
Female	51.1671	50.948	51.1006	50.7865	51.1691	50.9529
	[49.9865]	[49.9911]	[49.9906]	[49.9955]	[49.9864]	[49.991]
Married	40.9871	39.813	41.0179	41.7399	40.9862	39.7552
	[49.181]	[48.9513]	[49.1893]	[49.3146]	[49.1809]	[48.9392]
Own children in household (#)	.5152	.4893	.5484	.5426	.5142	.4877
	[.9735]	[.9605]	[1.0171]	[1.0246]	[.9722]	[.9584]
White Non-Hispanic	82.0178	79.7656	89.4271	85.0641	81.7953	79.6066
	[38.404]	[40.1748]	[30.7507]	[35.6454]	[38.5884]	[40.2921]
Black Non-Hispanic	11.2198	11.4804	1.2998	1.5924	11.5176	11.777
	[31.561]	[31.8785]	[11.3273]	[12.5187]	[31.9235]	[32.2336]
Hispanic origin	3.131	3.9615	4.3541	6.9783	3.0943	3.871
	[17.4155]	[19.5052]	[20.4083]	[25.4789]	[17.3163]	[19.2902]
High School or Equivalent	66.5208	70.1422	63.2673	66.3559	66.6185	70.2557
	[47.1918]	[45.7635]	[48.2103]	[47.2508]	[47.1575]	[45.7133]
Homeowner	72.8803	69.6431	70.4316	68.185	72.9545	69.6873
	[44.4578]	[45.9799]	[45.6375]	[46.5775]	[44.4196]	[45.961]
Observations	300793	495904	9246	14829	291547	481075

Source and notes: Author's calculations from ACS files. "Before" is calculated over 2006-2010. "After" is calculated over 2012-2019.

Table 2: Probability of Poverty Models

	(1) White	(2) White	(3) White	(4) Non-White	(5) Non-White	(6) Non-White
Joplin	0.051	0.042	-0.001	0.049	0.075***	0.004
	(0.029)	(0.022)	(0.001)	(0.028)	(0.012)	(0.002)
After 2011	0.008**	0.005***	0.005*	-0.023***	-0.026***	-0.090***
	(0.003)	(0.001)	(0.002)	(0.006)	(0.004)	(0.011)
Joplin*After 2011	-0.036***	-0.030***	-0.034***	0.038***	0.022***	0.023***
	(0.003)	(0.001)	(0.003)	(0.006)	(0.004)	(0.004)
Age		0.002***	0.002***		-0.002***	-0.002***
		(0.000)	(0.000)		(0.000)	(0.000)
Age Squared/10		-0.000***	-0.000***		0.000***	0.000***
		(0.000)	(0.000)		(0.000)	(0.000)
Female		0.020***	0.021***		0.020***	0.020***
		(0.004)	(0.004)		(0.003)	(0.003)
Married		-0.101***	-0.103***		-0.132***	-0.136***
		(0.016)	(0.016)		(0.008)	(0.011)
Number of own children in the household		0.022***	0.022***		0.040***	0.040***
		(0.005)	(0.005)		(0.003)	(0.003)
High School or Equivalent		-0.080***	-0.071***		-0.108***	-0.103***
		(0.016)	(0.013)		(0.010)	(0.010)
Homeowner		-0.190***	-0.184***		-0.232***	-0.231***
		(0.014)	(0.015)		(0.004)	(0.004)
Constant	0.138***	0.295***	0.327***	0.293***	0.467***	0.562***
	(0.029)	(0.041)	(0.020)	(0.028)	(0.015)	(0.006)
Metropolitan Area Fixed Effects?	no	no	yes	No	no	yes
Year Fixed Effects?	no	no	yes	No	no	yes
Observations	676,826	650,857	650,857	119,871	110,345	110,345
R-squared	0.000	0.109	0.121	0.001	0.136	0.143

Robust standard errors in parentheses, clustered at the metropolitan area level.
*** p<0.01, ** p<0.05, * p<0.1
Source: Author's calculations from ACS files.

Table 3: Relocation Models, Stayers

	(1) White	(2) White	(3) Non-White	(4) Non-White
Joplin	0.004	0.011**	0.038***	0.047**
	(0.003)	(0.004)	(0.002)	(0.014)
After 2011	0.034***	0.093***	0.069***	0.100*
	(0.009)	(0.021)	(0.007)	(0.047)
Joplin*After 2011	0.011**	0.001	0.031***	0.019
	(0.004)	(0.005)	(0.004)	(0.018)
Average Non-White to White Poverty (last year)		0.010*		0.011
		(0.005)		(0.013)
Average Non-White to White Poverty (last year)*After 2011		-0.024**		-0.010
		(0.007)		(0.015)
Age	0.003***	0.003***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
Age Squared/10	-0.000	-0.000	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Female	-0.001	-0.001	0.005**	0.005**
	(0.001)	(0.001)	(0.002)	(0.002)
Married	0.020***	0.020***	0.004	0.004
	(0.002)	(0.002)	(0.007)	(0.007)
Number of own children in the household	0.005**	0.005**	0.005*	0.005*
	(0.002)	(0.002)	(0.002)	(0.002)
High School or Equivalent	-0.082***	-0.082***	-0.065***	-0.065***
	(0.015)	(0.015)	(0.006)	(0.006)
Homeowner	0.241***	0.242***	0.204***	0.204***
	(0.003)	(0.003)	(0.006)	(0.006)
Constant	0.593***	0.565***	0.589***	0.558***
	(0.006)	(0.015)	(0.005)	(0.038)
Metropolitan area fixed effects?	yes	yes	yes	yes
Year fixed effects?	yes	yes	yes	yes
Observations	644,175	644,167	108,601	108,601
R-squared	0.128	0.128	0.093	0.093

Robust standard errors in parentheses, clustered at the metropolitan area level

*** p<0.01, ** p<0.05, * p<0.1

Source: Author's calculations from ACS files.

Table 4: Relocation Models, Newcomers

	(1) White Within State Move	(2) White Within State Move	(3) Non-White Within State Move	(4) Non-White Within State Move	(5) White From Out of State	(6) White From Out of State	(7) Non-White From Out of State	(8) Non-White From Out of State
Joplin	-0.007*	-0.015***	-0.024***	-0.029**	0.003**	0.004	-0.014***	-0.018**
	(0.003)	(0.002)	(0.002)	(0.009)	(0.001)	(0.003)	(0.001)	(0.007)
After 2011	-0.033***	-0.097***	-0.062***	-0.076**	-0.001	0.004	-0.007	-0.024
	(0.009)	(0.011)	(0.005)	(0.029)	(0.002)	(0.012)	(0.005)	(0.027)
Joplin*After 2011	-0.009	0.003	-0.035***	-0.029**	-0.002	-0.003	0.004***	0.010
	(0.005)	(0.002)	(0.004)	(0.012)	(0.002)	(0.003)	(0.001)	(0.009)
Average Non-White to White Poverty (last year)		-0.011**		-0.005		0.001		-0.005
		(0.004)		(0.009)		(0.003)		(0.007)
Average Non-White to White Poverty (last year)*After 2011		0.026***		0.004		-0.002		0.005
		(0.004)		(0.009)		(0.004)		(0.009)
Age	-0.002***	-0.002***	-0.001***	-0.001***	-0.001**	-0.001**	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age Squared/10	0.000*	0.000*	-0.000	-0.000	0.000	0.000	-0.000*	-0.000*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female	0.002*	0.002*	-0.001	-0.001	-0.001	-0.001	-0.003***	-0.003***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Married	-0.022***	-0.023***	-0.023**	-0.023**	0.003**	0.003**	0.019***	0.019***
	(0.002)	(0.002)	(0.007)	(0.007)	(0.001)	(0.001)	(0.003)	(0.003)
Number of own children in the household	-0.002	-0.002	0.002	0.002	-0.003***	-0.003***	-0.007***	-0.007***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
High School or Equivalent	0.064***	0.064***	0.046***	0.046***	0.019***	0.019***	0.019***	0.019***
	(0.011)	(0.011)	(0.007)	(0.007)	(0.005)	(0.005)	(0.003)	(0.003)
Homeowner	-0.199***	-0.199***	-0.168***	-0.168***	-0.042***	-0.042***	-0.036***	-0.036***
	(0.004)	(0.004)	(0.005)	(0.005)	(0.003)	(0.003)	(0.006)	(0.006)
Constant	0.345***	0.376***	0.330***	0.345***	0.063***	0.059***	0.081***	0.097***
	(0.009)	(0.015)	(0.004)	(0.026)	(0.005)	(0.010)	(0.003)	(0.022)
Metropolitan area fixed effects?	yes	yes	yes	yes	yes	yes	yes	yes
Year fixed effects?	yes	yes	yes	yes	yes	yes	yes	yes
Observations	644,175	644,167	108,601	108,601	644,175	644,167	108,601	108,601
R-squared	0.105	0.105	0.077	0.077	0.019	0.019	0.018	0.018

Robust standard errors in parentheses, clustered at the metropolitan area level.
*** p<0.01, ** p<0.05, * p<0.1

Figure 1: Fraction on Nonwhite and White populations in poverty by year

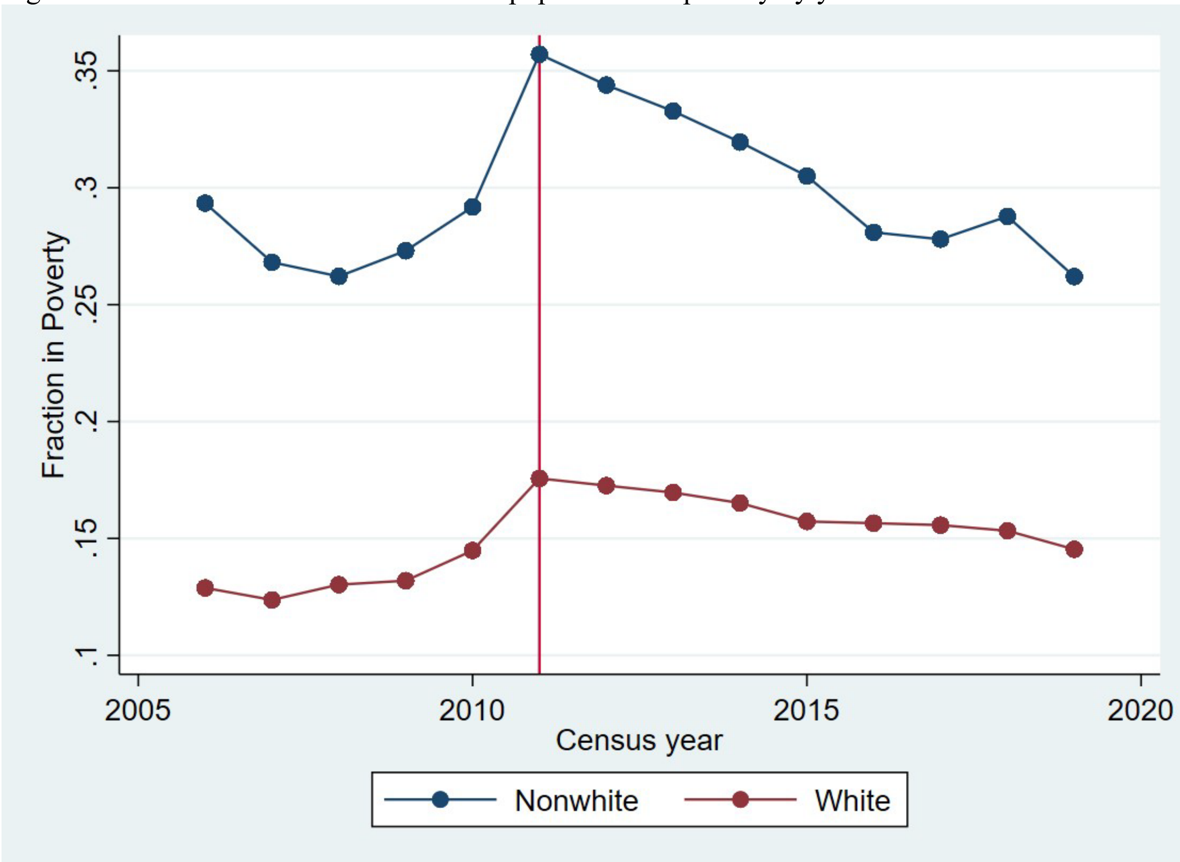

Figure 2: Fraction of population that stays within the same home as last year