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Housing Recovery after Disasters: Primary Versus Seasonal and Vacation Housing Markets in Coastal Communities*

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Abstract

Recovery of seasonal housing after disasters is driven by different types of decisions and resource streams than those of year-round homes. Given the importance of seasonal rentals in the economy of coastal and particularly island communities, understanding the levels and recovery trajectories of seasonal housing may inform overall recovery expectations. The authors report findings from an empirical study of impact and recovery trajectories for owner-occupied and rental single-family housing in housing sub-market areas in Galveston, Texas following Hurricane Ike using random effects panel models to predict the parcel-level values over an eight-year period. Divergent impact and recovery trajectories and processes were found when comparing housing in residential markets with those in dynamic versus more languid vacation housing markets. Damage, tenure, minority population, and income all had significant effects on trajectories with varying direction and magnitudes across submarkets. These differences in the mechanisms of submarkets and vulnerability in recovery trajectories of coastal communities highlight the importance of mapping the influential factors in each area to target mitigation and recovery assistance effectively.

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Keywords: disaster, housing recovery, coastal, vacation submarket

Introduction

Through a comparative analysis of housing recovery across a variety of disasters in the United States (U.S.), Mary Comerio (1998) was one of the first researchers to explicitly examine the uneven rate of recovery among different forms of housing, noting that housing recovery policy in the United States, due to its focus on single-family owner-occupied housing, plays an important role in shaping these inequalities. Comerio drew the research community's attention to different forms of housing as relevant factors when modeling housing recovery and informing or modifying policy alternatives to address uneven recovery rates. Since then, researchers have explored and documented many factors including damage, tenure, and social vulnerability elements such as race/ethnicity and income. Importantly, while post disaster planning for housing recovery has sometimes been discouraged (Peacock & Girard 1997), there is also a growing literature on the importance of planning for successful and equitable community recovery in general and for housing in particular (Van Zandt and Sloan, 2016; Olshansky, Hopkins, & Johnson, 2012; Federal Emergency Management Agency (FEMA), 2011; Olshansky & Johnson, 2014; Smith, 2011). However, there is clear recognition that planning is falling short in addressing housing recovery beyond owner-occupied single-family (FEMA, 2009; Cantrell, Nahmens, Peavey, Bryant, & Stair, 2012) and better understanding of differential patterns in housing recovery is needed (Zhang & Peacock, 2010; Peacock, Van Zandt, Zhang, & Highfield, 2014; Olshansky & Johnson, 2014).

This work expands recent housing recovery research (e.g. Elliott & Pais, 2006; Elliott, Hite, & Devine, 2009; Zhang & Peacock, 2010; Stevenson, Emrich, Mitchell, & Cutter, 2010; Cutter, Schumann, & Emrich, 2014; Peacock et al., 2014) by examining damage and recovery trajectories for owner-occupied, rental, and vacation housing in a coastal community for an 8-year period through a longitudinal impact-recovery model. Like many coastal communities, Galveston has a core area consisting of traditional residential housing, including owner-occupied and rental housing, as well as areas with high concentrations of vacation rentals and second homes. The following section reviews the housing recovery literature and introduces the potential significance of housing submarkets within coastal communities to better understand and capture inequalities in housing recovery trajectories. A discussion of Galveston and Hurricane Ike is then provided and the analysis strategy for modeling impact and recovery is introduced. Following the analysis and findings, the implications for recovery planning practice and research are discussed.

Housing Recovery in Coastal Communities

Each year hurricanes pose a significant threat to communities along the U.S. Gulf and Atlantic Coasts. The coastal environments of these communities can shape their economies, especially in terms of tourist activities, introducing unique features to their housing markets. While a conventional housing market consisting of typical owner-occupied and rental housing serves local residents, there is also the potential for a relatively large seasonal housing market. Among the approximately 5,000 communities located in National Oceanic and Atmospheric Administration (NOAA) defined coastal counties in Gulf and Atlantic coast states, the 2015 5-year American Community Survey (ACS) data indicates that a quarter have vacancy rates of 25% or more, with 40% or more of this housing devoted to seasonal-vacation housing. Seasonal housing is a mix of second/vacation homes, which can double as vacation rentals when not in use by owners, and full-time vacation rentals and timeshares. Vacation housing is often concentrated in areas with unique types of amenities and businesses, with little need for schools and with alternative factors shaping sales relative to traditional neighborhoods. Importantly, decisions to repair or rebuild after a disaster may differ for the owners or managers of second and seasonal vacation homes compared to the owners of conventional housing, influenced in part by the differences in recovery resources available to finance rebuilding and repairs.

Owner-occupants have a range of potential resources for repairs and rebuilding, comprising of personal or household savings, insurance, and loans, including low-interest Small Business Administration (SBA) loans, as well as safety-net programs such as minimum home repair under FEMA's Individual and Household Program (IHP). Insurance can include private, specific hazard related insurance such as earthquake insurance, or special hazards related insurance such as semi-public/private state managed wind pools and the national flood insurance program. In recent years the Department of Housing and Urban Development (HUD) has also developed a Community Development Block Grant (CDBG) Disaster Recovery Program which, if there is supplemental Congressional funding, can make available flexible grants to help fund private home repair and reconstruction (HUD, 2017; Gotham, 2014; Olshansky & Johnson, 2014).

For the owners of vacation or second homes, the range of recovery sources is more limited. FEMA's IHP is not available to address even their minimal repairs (FEMA, 2017; SBA, 2017b). These owners will depend on savings, insurance, and other loans including SBA (SBA 2017c). If a business receives an SBA loan, the loan is to replace the property, not for upgrading, with the exception of bringing the property up to existing building codes and mitigation to prevent future damage of up to 20% of the property's value. In some cases, CDBG recovery funds may be available to address year-around rental housing (HUD, 2017c). The owners of rental properties, along with loan officers or financial backers, are making business decisions regarding anticipated future earnings versus the costs of repair or reconstruction. The nature of these decisions may differ based on target markets – seasonal tourists versus year-round residents – and the uncertainty of whether or not both will return. Within each of these target populations there are various strata from low- to higher-income households that may modify the decision of owners/managers to repair/rebuild. For example, the literature suggests a tendency for the owners of year-round rentals, once repaired, to increase rents, targeting higher-income renters, perhaps in the hopes of recouping reinvestments more quickly (Quarantelli, 1982; Drabek & Key, 1984; Morrow & Peacock, 1997; Morrow & Enarson, 1997; Bolin & Stanford, 1998). Such decisions may reduce the availability of post-disaster rental housing for lower-income households (Peacock et al., 2014).

The notion of submarkets, their importance for shaping and understanding a housing market, and their consequences for policy are not new. Megbolugbe et al. (1996:1780), in their discussion of Grigsby's (1963) pioneering work, *Housing Markets and Public Policy*, noted that one of the primary reasons for publishing that research "was to alert planners and public officials that understanding the operation of housing markets must precede policy prescriptions for housing problems" a theme echoed by Glaeser (1996) and Bates (2006). Leishman, Costello, Rowley, & Watkins (2013), drawing on the work of Grigsby (1963), Maclennan (1982), and Watkins (2008) note that housing submarkets arise due to demand-side heterogeneity in preferences and supply-side differences in housing stock. Furthermore, they and others have noted that understanding submarkets can improve the effectiveness of public policy and public sector expenditures, tax incentives, and private sector investments (Bates, 2006; Berry, McGreal, Stevenson, Young, & Webb, 2003; Goodman & Thibodeau, 2007; Rothenberg, Galster, Butler, & Pitkin, 1991; Schnare & Struyk, 1976).

Given the importance of understanding housing submarkets for housing issues and policy in general, it is reasonable to suggest that submarkets may influence variations in housing recovery. Decisions to rebuild are shaped by homeowner preferences for staying in their homes and the availability of resource streams for repair and rebuilding. This heterogeneous mix of preferences, rebuilding decisions, varying recovery resources, and uncertain demand suggest mixed recovery trajectories for owner and rental housing stocks between conventional versus seasonal housing submarkets. While not addressing submarkets explicitly, Cutter et al. (2014) used the percent of seasonal rentals at tract level, as an indicator of tenure when modeling individual house recovery following Hurricane Sandy. They concluded that housing in tracts with high percentages of seasonal/second homes recover more slowly during the first 6 months, but showed no consequence by a year after the storm. This paper directly assesses variations in impact and recovery between seasonal and more traditional housing markets.

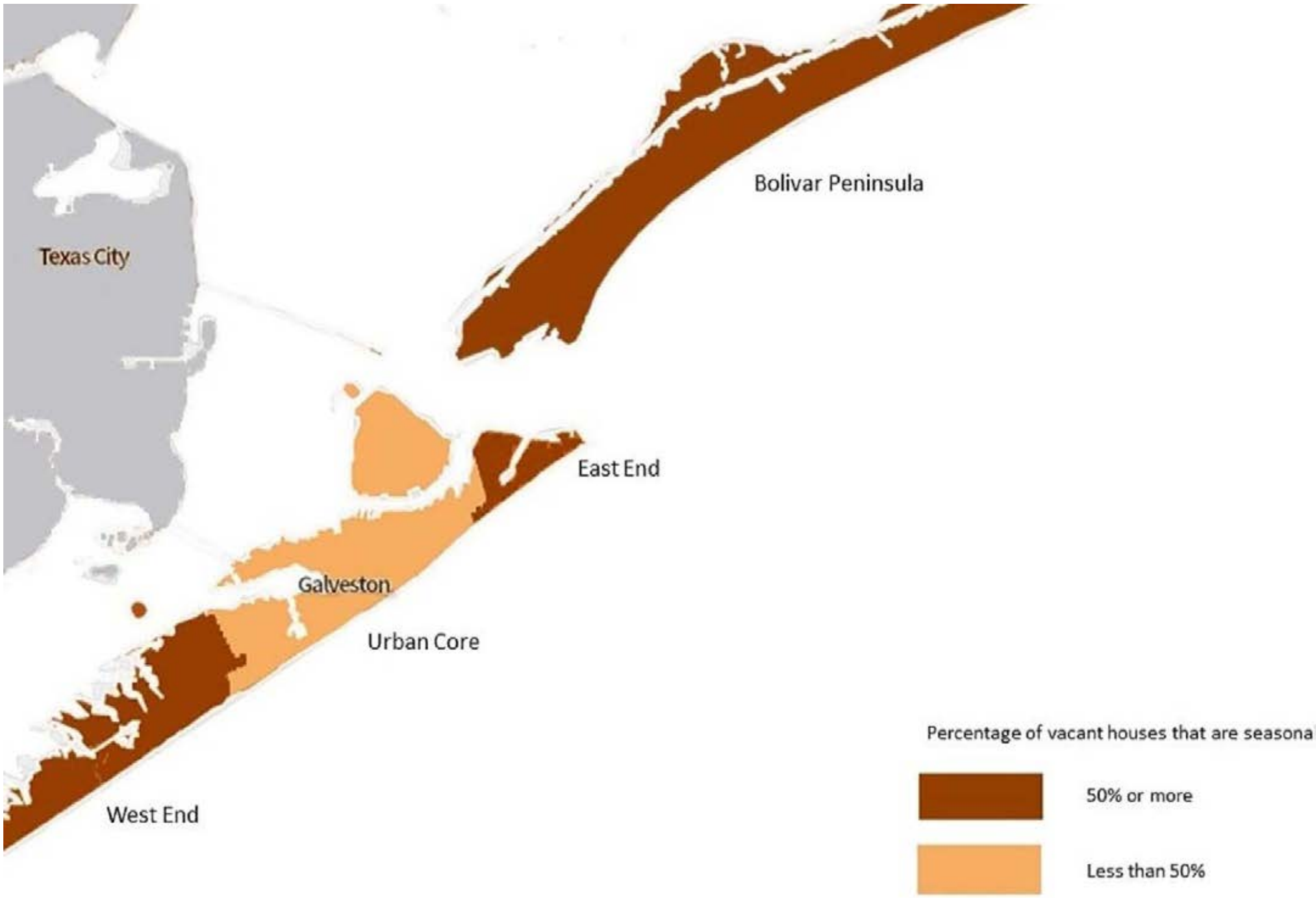
Models of housing recovery have found that other factors such as race/ethnicity and income have important implications for access to resources and can be related to another critical factor shaping recovery—levels of damage. Unsurprisingly, the level of damage sustained by homes has significant debilitating effects on both short and long-term recovery (Zhang & Peacock, 2010; Peacock et al., 2014). However, damage levels are a function of the hazard agent itself and are related to housing conditions associated with housing type and tenure (Maly & Shiozaki, 2012) neighborhood characteristics such as income and race/ethnicity (Bolin, 1982 & 1985; Bolin & Bolton, 1983 and 1986; Peacock & Girard, 1997; Van Zandt, Peacock, Henry, Grover, Highfield, & Brody, 2012; Gotham, 2014; Highfield, Peacock, & Van Zandt, 2014; Peacock et al., 2014). This relationship between high levels of damage and social vulnerability factors results from filtering (Grigsby, 1963; Myers, 1975) whereby older, lower valued, and poorer quality homes often house low-income and minority populations (Van Zandt et al., 2012; Peacock et al., 2014). Consequently, the physical and social concentration of damage sets the stage for very different recovery trajectories for housing in lower-income and minority neighborhoods (Chang, 2010; Comerio, 1997; Green, Bates, & Smyth, 2007; Green & Olshansky, 2012; Zhang, 2012).

The few systematic empirical studies on long-term housing recovery have found that rental housing, housing with higher levels of damage, and housing in low-income and minority neighborhoods have significantly slower recovery trajectories (Lu, Peacock, Zhang, & Dash 2007a & 2007b; Zhang & Peacock, 2010; Peacock et al., 2014). One reason for such disparity is that the current disaster assistance programs in the U.S. continue to favor single-family homeowners (Bolin 1993; Comerio 1997 & 1998; Bolin and Stanford 1998). More recently, rental housing recovery was found to be slower after Katrina where assistance programs for landlords and renters appeared to be less aggressive (Vigdor, 2008). Since SBA loans are not grants, lower income areas are likely to be underserved by them (Kamel & Loukaitou-Sideris 2004). Insurance generally favors higher income households, and insurance redlining can often leave minority households without sufficient insurance due to under-compensation or bankruptcy by marginal companies (Peacock & Girard, 1997; Scales, 2006; Bates & Green 2009). When analyzing recovery trajectories, these factors will be considered in the assessment of submarket consequences.

Hurricane Ike and Galveston

Hurricane Ike crossed between Galveston Island and Bolivar Peninsula (see Figure 1) on the morning of September 13, 2008 as a Category 2 storm, causing $29.5 billion in damage to the Houston-Galveston area, making it one of the costliest storms in U.S. history (Berg, 2009). Galveston’s core was protected by the seawall, erected after the deadly 1900 storm but it was nevertheless inundated from the bay side with 3 to 4.5 meter (10 to 15 feet) destructive waves. Damage to residential structures on Bolivar was three times higher than levels recorded on the

Figure 1- Vacation homes by census tract



island. Residential damage was more variable on the island, with higher levels occurring outside the seawall and among homes closer to the bay side (Highfield et al., 2014).

The 16-kilometer (10-mile) long, 5-meter (17 feet) high seawall has not only protected residential structures on Galveston during many storms, it has also shaped development and ultimately residential versus seasonal housing markets. The vast majority of Galveston's residential housing has historically been and remains behind the seawall in its urban core. Yet increasing development pressures, particularly for vacation housing, has expanded development outside the seawall toward what is termed the East and particularly the West ends of the island. Tourism related to its beaches and Galveston's historic homes, seawall, and business district (the Strand) is its fastest growing industry (Angelou Economics, 2008; Gulf & South Atlantic Fisheries Foundation, 2010). Despite the higher risks of storm damage and constant erosion on the West End beyond the seawall, the city has subsidized development through tax-increment reinvestment zones and creating a favorable environment for builders/developers (Beeton, 2008). Development on Bolivar Peninsula has been much more limited historically due to its relative isolation and dependence on ferry service from Galveston Island.

The housing market literature has for long debated how best to measure housing markets and submarkets (Bates, 2006; Bourassa, Hamelink, Hoesli, & MacGregor , 1999) ranging from segmentation assessments based on housing attributes such as price or size (Goodman & Thibodeau, 2007; Adair, Berry, & McGreal, 1996; Plam, 1978), population or demand attributes such as race or income (Schnare & Struyk, 1976; Adair et al., 1996; Palm, 1978; Watkins, 2001), to spatial assessments based on census units, zip codes, or physical boundaries (Bourassa, Hoesli, & Peng, 2003; Goodman & Thibodeau, 2003, 2007), or combinations of these (Tu, 1997; Watkins, 2001). For this research the issue is to identify areas where traditional residential versus seasonal housing are dominant enough to assert their salience in shaping rebuilding decisions and recovery resources. To identify these submarkets in Galveston, ACS tract data for 2005-2009 were employed. These ACS period data are less than optimal because 15 of the 60 months fall after Hurricane Ike. Unfortunately, three-year estimates for 2005-07 are not available at the tract or smaller census unit level. Hence, the 2005-09 data are the only available data near the period of interest, 75% of the data for this period were collected prior to Ike and they provide the finest resolution data for capturing housing market variations of interest. There are 23 tracts on Galveston Island and Bolivar Peninsula and four had high concentrations of 50% or more of vacant housing devoted to seasonal, recreational, or occasional use. These tracts are consistent with locally-identified vacation areas on Galveston Island, the West End (two tracts) and the East End (one tract), and the Bolivar peninsula (one tract). As shown in Figure 1, all vacation areas are outside the urban core and its seawall.

Table 1 displays housing unit characteristics for these areas. The urban core includes a majority, 73.0%, of Galveston's housing units with 33.3% single-family owner-occupied and a mixture of single-family, duplexes, and multifamily devoted to rental housing at 41.9%. The remaining, 24.9%, is vacant, with the majority for rent or sale or transitioning between renters or owners, and only 16.8% for seasonal vacation use. The only similarity between the urban core and the island's vacation area is that 30.0% of housing is owner-occupied. However, only 15.4% is rental in the island's seasonal vacation area with the majority, 55%, of housing vacant and over 72.1% of this vacant housing is for seasonal vacation use. The average median value of owner-occupied housing in the urban core is $122000 ($122K), while in the island vacation area it is higher at $178K. There are important variations in house age, reflecting differences in building codes, standards, and location that correspond to hazard vulnerability between these markets as well (for a detailed explanation, see Highfield et al., 2014).

The researchers identified two distinct seasonal vacation markets in the study area. The seasonal vacation housing submarket on Galveston Island is more dynamic, upscale, and has experienced more recent growth, while Bolivar's is more isolated, has experienced limited growth and is less affluent. Both of these areas contrast to the more historical and yet conventional residential housing market in the urban core.

Research question and hypotheses

The primary question motivating this research is whether the specification of residential versus vacation housing submarkets improves the performance of impact-recovery models for Galveston following Hurricane Ike. Based on the literature, there are clear expectations with respect to housing impact and recovery:

Hypothesis 1 (H_{1}): Higher degrees of damage will slow recovery;

H_2: Owner-occupied housing will suffer less damage;

H_3: Owner-occupied housing will recover more quickly;

H_4: Housing in higher income neighborhoods will suffer less damage;

H_5: Housing in higher income neighborhoods will recover more quickly;

H_6: Housing in neighborhoods with higher minority (Hispanic and non-Hispanic Black) concentrations will suffer more damage.

H_7: Housing in neighborhoods with higher minority (Hispanic and non-Hispanic Black) concentrations will recover more slowly.

Data and Analytical Approach

Annual tax assessments for single-family residential structures in Galveston Island and Bolivar Peninsula provide the data for this research. An established literature justifies the use of property assessments to track damage and recovery (Bin & Kruse, 2006; De Silva, Kruse, & Wang 2006**;** Fujita, 1989; Knaap, 1998; Peacock et al., 2014; Zhang & Peacock, 2010), but this is the first time that an 8-year panel from pre-impact, 2008, through impact, 2009, and recovery years, 2010-2015, has been used to assess long-term recovery. Previous long-term recovery models have only provided 3 years of post-impact data, which was insufficient for many structures to reach restoration levels (Peacock et al., 2014; Zhang & Peacock, 2010). It may appear confusing that 2008 data is the year prior to Hurricane Ike, which hit in mid-September of 2008. Tax appraisals are generally undertaken during the first two quarters of the year and then made official at the end of the year. Hence the 2008 assessment reflects the value of structures generally during the first half to three quarters of 2008, prior to any damage caused by Ike. The 2009 assessment captures the deflated value of homes impacted by Ike. Given that owners were paying property taxes on undamaged structures in 2008, the Galveston appraisal office took steps to inspect structures so that assessments would capture damage, as well as potential repairs, rebuilding, and improvements. Nevertheless, given the timing of appraisals, the assessments are only an approximate assessment of damage and recovery measures. Only single-family structures are employed in this analysis because the data on multifamily structures was incomplete in terms of the number of units in the structure, which therefore precludes an accurate analysis of recovery for different forms of multi-family structures.

Parcel data provide information on house characteristics such as year built, size, and occupancy. Owner-occupancy is based on the homestead exemption, which can only be taken on the primary residence. Structures without a homestead exemption include rentals and second homes. Since parcel data does not provide data on household characteristics, each house is linked to its block group location and assigned 2005-2009 five-year ACS data capturing neighborhood socio-demographic attributes – median household income, percent Hispanic, and non-Hispanic Black. The final dataset includes 186,280 observations comprising 23,285 single-family houses (12,236 (52.5%) urban core, 6,033 (25.9%) Galveston vacation area, and 5,016 (21.5%) Bolivar vacation market) with eight points in time for each structure.

The analysis strategy employed in this research develops statistical models predicting the changing assessed values of single-family homes from a baseline (2008) year, just prior to the hurricane's potential impact, through impact (2009), and into post-impact or what is generally referred to as the recovery period (2010-15). Hence, the authors refer to the present models as impact-recovery models because they model housing from an initial pre-impact state, through impact, and into a "recovery" period. Specifically, the researchers employ random effects panel models predicting the natural log of assessed values for each structure over an eight-year period. The theoretical literature posits and the empirical literature has found that a number of time-invariant factors (i.e., social vulnerability and socioeconomic factors) across residential parcels have influence on disaster impact and recovery. Random effects models allow for the inclusion and assessment of both time invariant and variant factors and hence are employed for this analysis. The basic impact-recovery model is specified as follows:

$$lnHV_{it} = \beta_0 + \sum_{T=1}^{7} \delta_T Yr_{it} + \sum_{k=1}^{2} \beta_k C_{it} + \beta_3 Dm_{it} + \sum_{j=1}^{4} \beta_j X_{it} + \gamma_{it}$$

[1]

Where $\ln HV_{it}$ is the natural log of assessed value for each single-family house *i* for each year *t*. The intercept, β_0 is the estimated average logged structure value in the base year, 2008, when other variables, are at zero and Yr_{it} is a series of seven dummy variables for each year following the base year. Hence, δ_T represents the difference in the average structure value from the base year, controlling for other factors, through the impact and recovery period. C_{it} represents two control variables (house age and size) and β_k captures their effects, net of other factors, where age is anticipated to have a negative effect and size a positive effect. Dm_{it} is relative damage, the percent assessed value loss due to Ike's impact, and its coefficient, β_3, captures the effect of damage. X_{it} represents four key independent variables (owner-occupied dummy, median income, percent Hispanic, and percent non-Hispanic Black) and the β_j's represent their individual effects, while γ_{it} is a composite error term. In addition to the base model, a more elaborate random effects model is employed that allows the effects of the key independent variables to vary through time as follows:

$$
\begin{aligned}
lnHV_{it} = \beta_0 + \sum_{T=2}^{7} \delta_T Yr_{it} \\
+ \sum_{k=1}^{2} \beta_k C_{it} + \beta_3 Dm_{it} \\
+ \sum_{j=1}^{4} \beta_j X_{it} + \sum_{T=3}^{7} \delta_T (Dm_{it} * Yr_{it}) + \sum_{T=2}^{7} \delta_T (X_{it} * Yr_{it}) + \gamma_{it}
\end{aligned}
$$

[2]

This equation has two sets of interaction terms, in which the damage measure, Dm_{it}, and the four additional key independent variables, X_{it}'s, are multiplied by year dummy variables. Since damage is not registered until 2009, there are interaction terms for six years, but for the other key independent variables interactions change for seven years. Hence the δ_T coefficients capture the net difference in the effects of damage through the recovery period and of other independent variables through the impact and recovery period over their base effects.

Analysis and Findings

The first phase in the analysis determined if individual submarket models (i.e., separate panel models for housing in each submarket) perform better than a pooled model (i.e., a single model with housing from all submarkets combined). A two-step process was employed. Because of space limitations, the models estimated for each step is not presented in the paper, rather their results are discussed. First, two indicator (dummy) variables one for urban core (1 if urban core, 0 otherwise) and the other for Bolivar (1 if Bolivar, 0 otherwise) houses, with island vacation areas as the reference category, were added to the models. Tests for improvement in model performance were significant in both cases (For Model 1 the test for adding the two indicator submarket variables was Wald = 1587.30, $p \leq .0001$ and for Model 2 the test was Wald =1905.13, $p \leq .0001$). Having confirmed initial submarket differences, the second step added interaction terms between submarket indicators and key independent variables in both models. The test results were again significant (Model 1: Wald = 37838.68, $p \leq .0001$; Model 2: Wald = 250000, $p \leq .0001$), indicating that the effects of the independent variables and hence, the processes, varied significantly among submarkets, justifying employing separate submarket impact-recovery models.

Table 2 presents the descriptive statistics for each submarket area. As expected housing in the island's vacation area is much younger, 17.7 years compared to the older housing in the urban core averaging 32 years, with Bolivar falling in-between at 21.3 years. Average housing sizes are largest in the island vacation areas, followed by the urban core, and relatively small on Bolivar.

Notably, owner-occupancy of single-family houses is only 22.6% on Bolivar, 29.4% in the island vacation area, but over 58% in the urban core. The variations in damage are dramatic. Housing in the island vacation area lost on average 22% of its pre-Ike assessment and 33% in the urban core, but a devastating 72.8% on Bolivar. Not surprisingly, given the aforementioned, median income for the island vacation area was $56.7K, followed by the urban core at $38.7K and Bolivar at $33.3K. The urban core's neighborhoods are much more diverse with an average of 31.4% Hispanic and 18.4% non-Hispanic Black, while vacation areas are overwhelmingly Anglo, particularly on Bolivar.

Table 3 presents Models 1 and 2 results for each submarket. These random effects panel models are estimated using generalized least squares (GLS) with robust standard errors to address issues of heteroskedasticity and serial auto-correlation. Both models in each set are statistically significant, and tests comparing base and interactive models were significant across all sets, indicating that, as a whole, the effects of key variables change significantly through the damage and recovery periods. The year interaction coefficients capture net changes over baseline effects, but must be combined with base coefficient to capture the overall effects for specific years. While significance test for interaction coefficients assess its significance from zero, the combined effects (baseline + net) were tested for significance employing a Wald test. In light of these test results, the discussion focuses on similarities and differences revealed by the interactive models across submarkets and the base models are provided for reference.

The Impact of Damage Is Significant and Long Lasting

The effects of damage are profoundly significant across all areas, but particularly hard hitting for housing on Bolivar, given the nature of the storm The base damage coefficients indicate that every percentage point in damage resulted in appraised values falling -3.2% among houses in the urban core, -5.6% in the island's vacation area, and -11.6% on Bolivar. (Note, rather than using rule-of-thumb conversions for semi-elasticities (100*β), mathematically correct conversions, ($100*(e^{\beta x} – 1)$), are employed throughout our discussions.) The negative consequences continued throughout the recovery years in all areas, but patterns were different. In both the urban core and Bolivar, the year-damage interaction coefficients are positive and growing larger, which, when combined with base effect, indicates the consequences of damage are lessening as recovery proceeds. For example, by the seventh year after the storm on Bolivar, the combined effect of damage was -7.9% (or $100*(e^{(-.1232 + .0414)}-1)$ for every percentage point of damage and for housing in the urban core the combined effect was -1.76% (or $100*(e^{(-.0324 + .0147)}-1)$. For housing in Galveston island's vacation areas however, most of the damage-year interaction coefficients are negative, but non-significant, indicating that the negative effects of damage remain more or less constant, ranging between -5.63% to -6.13% and ending, by the seventh year, at -5.83% for every percentage point of damage suffered by the house. Thus, while the patterns are different, the effects of damage were profound for housing across all areas, particularly on the Bolivar peninsula, and the consequences continue to be felt seven years after Ike with more severely damaged homes experiencing greater difficulty reaching restoration levels. These findings are consistent with hypothesis 1.

Owner-occupied Housing Suffered Less Damage and Recovered More Quickly

An interesting, but not surprising pattern is evidenced by the baseline owner-occupied coefficient; owner-occupied housing was appraised significantly higher in the urban core (14.6% higher) and on Bolivar (8.1%), but significantly lower (-6.7%) in island vacation areas than non-owner-occupied housing. This probably reflects the relatively rapid, more recent growth of costlier vacation-seasonal housing in island vacation areas. Hypothesis 2 indicates that owner-occupied housing should have retained larger portions of pre-Ike value, indicating less damage; the results for the urban core and island vacation areas are consistent with this expectation. Specifically, the first owner-occupied-year interaction term is positive and significant in the urban core model indicating a net increase (retention given this was the damage impact year) of just over 7%, yielding a combined positive differential for owner-occupied housing of 22.7%. Among island vacation owner-occupied housing the negative baseline value is reversed by the significant, positive first interaction coefficient, indicating that owner-occupied housing in this area was valued at 4.5% higher after impact. Perhaps because of the catastrophic damage registered among all housing in Bolivar, the first interaction term for owner-occupied housing was not significant, indicating that while owner-occupied housing is still valued higher than other housing, it did not disproportionately retain value above other housing.

In light of recovery policy favoring owner-occupied housing, hypothesis 3 suggests that owner-occupied housing should move more rapidly toward recovery, a pattern consistent in the urban core and Bolivar, and while not as pronounced among homes in island vacation areas, also held there at least initially in the recovery process. In the urban core, the owner-time interaction terms are consistently significant, positive, and generally increasing indicating an increasing gap as owner-occupied housing substantially recovered faster relative to other forms of housing. Indeed, in the impact year owner-occupied housing in the core is 22.7% higher than other housing, grows to 27.8% two years after, 33.3% four years after, and is 38.4% higher by the sixth year and maintain that differential in the last year. There is a delay among Bolivar's owner-occupied houses, in that it is not until the fourth year after Ike that differentials are registered. However, by the fourth year, the combined effect has owner-occupied housing valued at 42.2% higher than other housing, growing to 56.4% by year-6 and ending at 54% by year-7. In island vacation areas owner occupied housing makes a significant positive jump of 4.5% (or 100*(e $^{(-0.0691733 + 0.1136285)}$- 1) above other housing in the first recovery year, particularly given the negative baseline value, but this gain appears to dissipate the next year. In the third year after Ike owner-occupied homes were again valued 7.5% higher than other housing, but this differential too dissipates in the remaining years. Nevertheless, owner-occupied housing does make gains relative to other housing in the recovery period in Island vacation areas and never again goes below valuations of other types of housing during the recovery period following Ike. On the whole, these results are consistent with hypothesis 3.

The Impacts of Neighborhood Income Are Consistent with Expectations in Traditional Residential Areas, but Divergent in Vacation Home Areas

In the urban core, in the base year assessed values of houses in higher income neighborhoods were higher. The significant positive base year coefficient indicates that assessments were .25% higher per $1,000 in median household income. The significant positive income-year 1 interaction indicates that, consistent with hypothesis 4, housing in higher income neighborhoods retained an additional .34% of their value per thousand dollars, meaning they experienced significantly less damage than homes in lower income areas. Consistent with hypothesis 5, the significant and positive income-year coefficients throughout the recovery period indicate higher recovery rates for housing in higher income neighborhoods. These gains are particularly strong through the third year after Ike, where the combined effect is .84% per thousand dollars; they remain relatively stable the 4th-6th years and by the seventh year assessed values were .71% higher per thousand dollars in median household income.

The income effects are completely different in the island and Bolivar vacation areas. While the baseline coefficient is non-significant_ indicating that housing values are not dependent on neighborhood income prior to Ike in island vacation areas_ the significant negative income-year 1 interaction indicates that housing in higher income neighborhoods suffered greater relative damage. Furthermore, all subsequent interaction terms are significant and negative, indicating that housing in richer neighborhoods was slower in the recovery process. The negative combined effect of income increased steadily peaking in the fifth year after Ike, at -1.2% per thousand and remained essentially stable afterward. A similar, but stronger pattern is evident on Bolivar. The baseline coefficient indicates that assessments were lower, at -4.8% per $1,000 in median income and the gap widened considerably in the impact year, with the combined effect rising to -25.9% (or 100*($e^{(-.0493\ -0.250)}$-1)) per $1,000. In the subsequent years this differential grew rapidly reaching -54.0% per $1,000, by the seventh year. These findings suggest that housing in wealthier neighborhoods of predominantly vacation areas suffered more damage and their recovery progressed more slowly. Clearly, the results for the urban core are consistent with the expectations of hypotheses 4 and 5, however the results for the island vacation area and particularly for Bolivar are not.

The findings for Neighborhood Minority Composition Are Mixed with Respect to Expectations across Submarket Areas

As would be expected given the housing literature, single-family housing in traditional residential urban core neighborhoods with higher percentages of minority populations had lower assessed values. Baseline coefficients indicate that assessments were -0.44% and -0.60% lower for every percentage point increase in neighborhood Hispanic and non-Hispanic Black population respectively. However, unexpectedly subsequent Black and Hispanic year interaction terms are all significant and positive indicating that minority areas did not suffer disproportionate losses nor did they experience relatively slower recovery trajectories. The net effects however result in somewhat divergent patterns. With respect to non-Hispanic Black composition, the positive Black-year interaction terms consistently cancel-out the negative baseline effect, indicating no differentials in damage or recovery associated with non-Hispanic Black neighborhood composition. In other words, housing located in neighborhoods with higher concentrations of non-Hispanic Blacks, did not suffer higher levels of damage nor experienced slower recovery rates in Galveston's urban core. Indeed, initial differences in housing assessments due to non-Hispanic Black composition are not evident throughout the recovery period, although a marginally significant negative combined effect (-.18%) in 2015 suggest that racial differences might be reemerging. Houses in neighborhoods with higher proportions of Hispanics suffered less relative damage as well. The significant Hispanic-year1 coefficient suggests a reduction of the initial baseline differential in assessments associated with neighborhood Hispanic composition; hence, less relative losses for housing in these areas. Indeed, the combined significant effect of the Hispanic baseline and Hispanic-year1 interaction suggests a -.14% (or $100*(e^{(-.0044 + .0030)}-1)$) drop in assessed values for every percentage point increase in Hispanic population in the impact year. This is significantly less than the initial baseline differential of -.44% per percentage point. Additionally, the positive Hispanic-year interaction terms for year-2 through year-7 indicate that housing in neighborhoods with higher concentrations of Hispanics made net gains, indicating relatively higher recovery rates. However, the positive Hispanic-year interaction coefficients do not cancel out the initial negative baseline effect in post-Ike years two, four, six, and seven, yielding significant negative combined effects ranging from -0.08% to -0.13% per percentage Hispanic. While relatively small, given high concentrations of Hispanics in some neighborhoods, these differentials could represent as much as a 10% lower assessment value. Thus, despite the continued lower assessments in neighborhoods with higher concentrations of Hispanics, on the whole, the authors did not see higher relative losses or slower recovery rates for areas with higher concentrations of minorities in Galveston's traditional housing market, the urban core. In the urban core, the findings are not supportive of Hypotheses 6 or 7.

The effects of minority populations are mixed in vacation home areas of Galveston Island and Bolivar. In the island's vacation area, the baseline coefficient for Hispanic is not significant, indicating no initial differences in the assessments of housing associated with higher concentration of Hispanics. Additionally, the significant, positive Hispanic-year interaction coefficients through the impact and recovery period again indicates that single-family houses in Hispanic neighborhoods experienced smaller relative losses and fared better during recovery. Indeed, by the seventh year the significant combined effect indicates that housing is assessed at 4.5% $(100^*(e^{(.0006 + .0437)}-1))$ higher per percentage point of Hispanic population in Galveston island's vacation neighborhoods. A very different picture emerges for non-Hispanic Black composition. The significant baseline Black coefficient is negative, indicating that housing assessments were -1.1% lower with every percentage point of non-Hispanic Black in the island vacation neighborhoods. These houses also lost disproportionally due to Ike's impact, falling an additional -2.2% per percentage point Black population, yielding a combined effect of -3.3% in the impact year. Furthermore housing recovery was slower consistently falling behind. For the first three recovery years the combined deficient was significant at -5.3% per percentage point ending at -4.8% per non-Hispanic Black percentage in 2015. Clearly, the results for Galveston island's vacation neighborhoods with higher concentrations of non-Hispanic Black populations is consistent with hypotheses 6 and 7, while those for Hispanic neighborhoods are not.

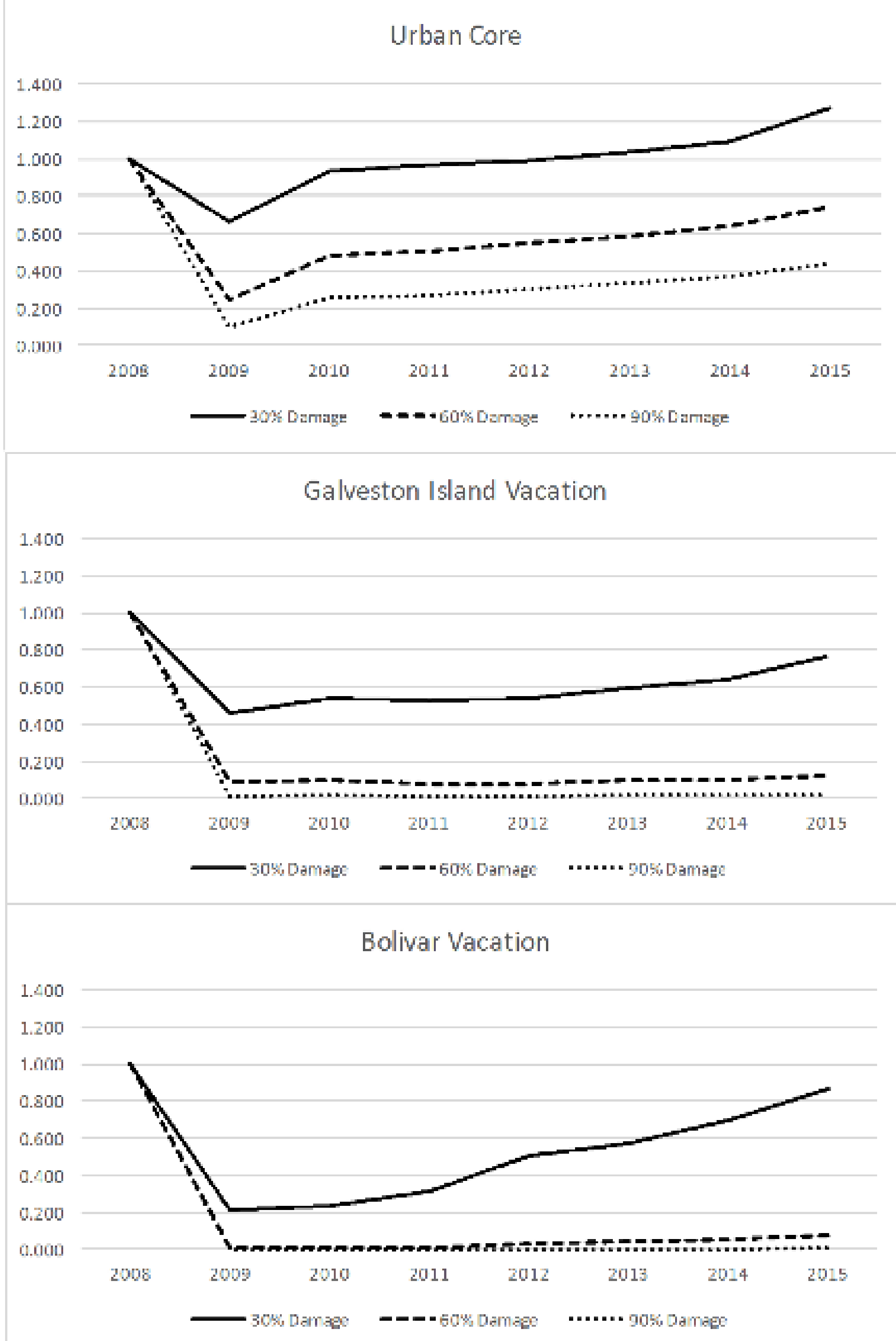
Bolivar has no Black population, nonetheless the finding for neighborhoods with higher concentrations of Hispanics are inconsistent with hypothesis 6, but consistent with 7. On Bolivar, houses in neighborhoods with higher Hispanic percentages had slightly lower values before Ike with assessments a -.81% per percentage point of Hispanics. However, the significant Hispanic-year1 interaction coefficient indicates that houses in these neighborhoods suffered significantly lower relative damage generating a surprisingly positive combined effect of 3.4% ($100*(e^{(-.0081+.0411)}-1)$) for every percentage point Hispanic. However, with the exception of the second year after Ike, all subsequent Hispanic-time interaction terms are negative and significant, indicating slower recovery. Indeed, by year 3 (2010), the combined negative effects were -2.4% ($100*(e^{(-.0081 - 0.0159)}-1)$) and became significantly more negative reaching a maximum of -7.5% ($100*(e^{(-0.0081 - 0.0701)}-1)$) by 2015. On Bolivar the findings are therefore inconsistent with respect to Hypothesis 6, but supportive of Hypothesis 7.

Discussion

The picture that emerges from the single-family housing impact-recovery analyses for Galveston's residential and vacation areas is far from simple. There clearly are quite divergent impacts and recovery trajectories when comparing housing in Galveston's traditional residential market with those of the more dynamic vacation area on Galveston Island and Bolivar's more staid (slower growing and older housing) vacation area. To facilitate discussion, the findings with respect to the hypotheses are summarized in Table 4 and a series of figures are offered to facilitate a visual interpretation of some results. The figures present predicted results derived from the full models computed by employing mean values for housing in each sub-market area (see Table 2) and a set of relevant values for variables under consideration. To further ease interpretation and comparison across areas and through time, predicted values were exponentiated and indexed relative to predicted baseline values (2008). Hence, trajectory plots begin at 1; values below 1 indicate assessments below 2008 values reflecting loss or failure to recover, values at 1 reflect *restoration* to baseline assessments, and values above 1 reflect *recovery* or gains above restoration levels.

As noted above, damage had significant, long-lasting negative consequences and the findings were consistent with H_1 across all areas (see Table 4, first row). However, the magnitudes were quite varied with profound, long-lasting negative consequences in Bolivar, lower but still substantial negative consequences for housing in island vacation areas, and even lower, diminishing, but still significantly negative consequences in the urban core. The consequences and differences are clearly evident in the trajectory lines for three levels of damage (30%, 60%, and 90%) in each area presented in Figure 2. Comparing the drops for respective damage levels across each area, it is clear that there are steeper drops in the vacation areas and these areas don't see the rapid positive bounces seen in the urban core in 2010. Indeed, housing suffering 30% damage levels in the core reach restoration levels by 2012. These differences may well reflect the very different array and levels of recovery resources open to more traditional residential homes dominating the urban core, versus seasonal, second, and occasional housing dominating vacation areas. The nature of the decisions to repair and rebuild for these different forms of housing, particularly with much higher levels of damage may also be playing a role in the very flat trajectories for severely damaged structures in vacation areas as well. It should be noted that while these damage levels were present in all areas, as seen in Table 2, the average damage levels were actually much lower among island vacation housing (22.6%), hence the typical trajectories are shallower and reach restoration levels more quickly. On the other hand, the average damage levels on Bolivar (72.8%) fell between the 60% and 90% levels; hence, the dramatic steep falls and flat trajectories were much more characteristic of a typical residential neighborhood.

Figure 2- Impact-Recovery Trajectories by Damage Levels

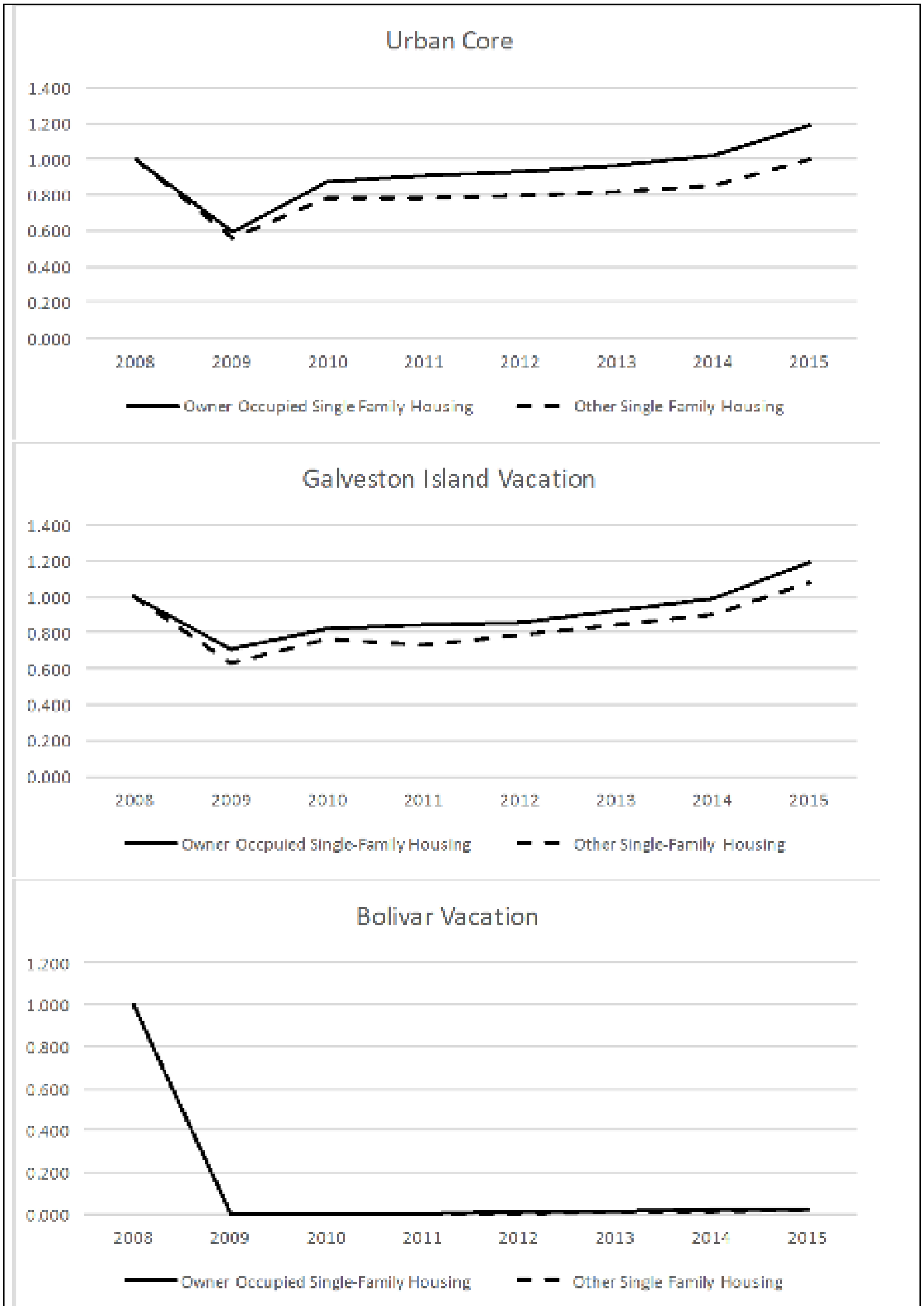


The predicted values for each figure were generated employing each sub-market model for owner-occupied housing with specified damage levels and submarket specific mean values for other independent variables. Predicted values have been exponentiated and indexed relative to 2008 predicted values.

Hypotheses with respect to owner-occupied houses (rows 2 and 3, Table 4) suffering less damage (H_2) and recovering more quickly (H_3) net of other factors, were supported, with the exception of damage differentials among Bolivar's single-family housing. This exception is likely due to the devastating levels of damage experienced by all housing on the peninsula. The panels in Figure 3, clearly capture the damage differentials in the urban core and island vacation areas. The differential recovery trajectories are most easily seen in both the urban core and island vacation areas, where owner-occupied housing rebounds much more quickly, with the growing gap particularly evident in the urban core. The significant gap in recovery trajectories are even evident in the Bolivar vacation area despite the devastation experienced there.

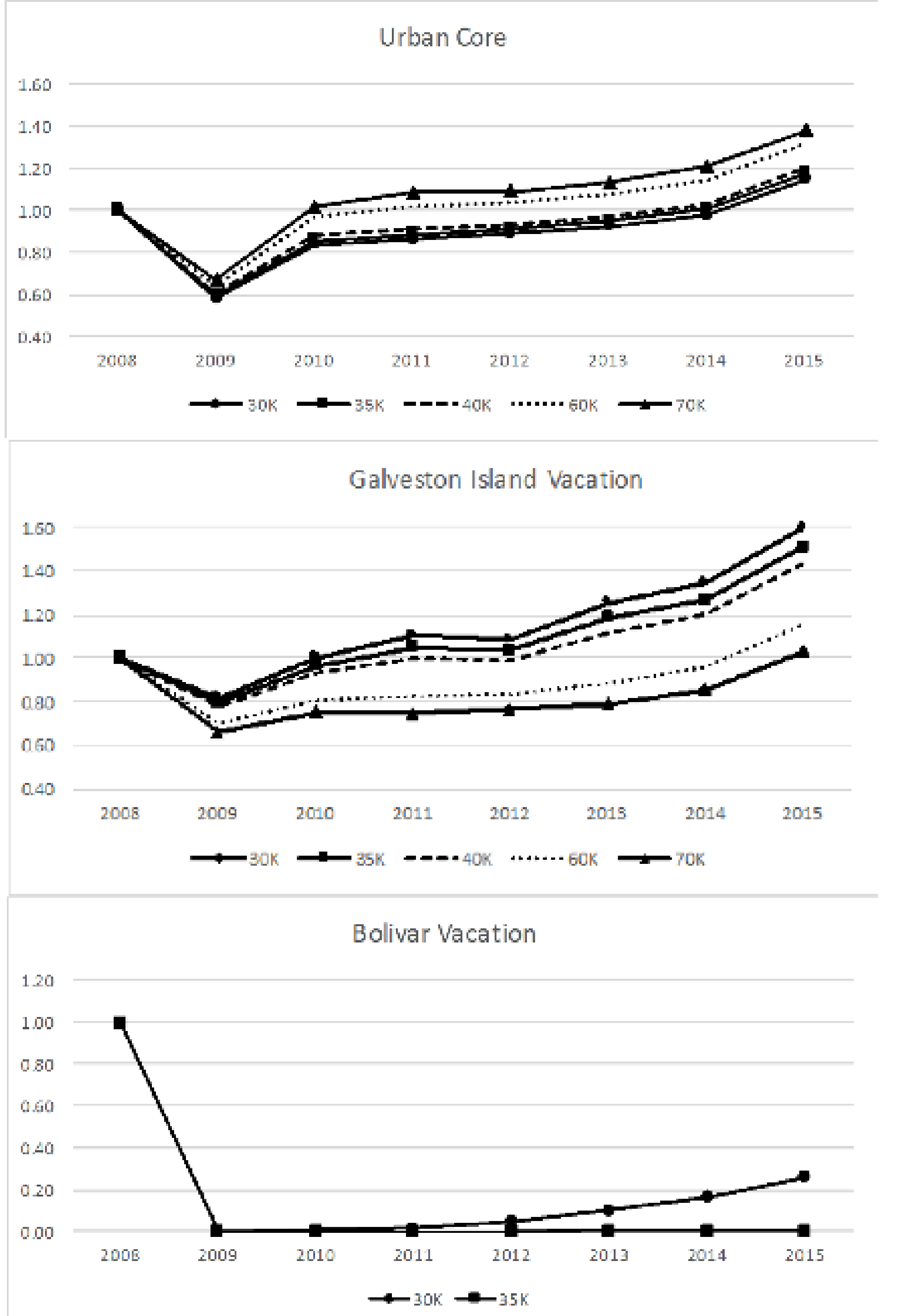
In addition to the different consequences of damage seen between Galveston's residential housing in the urban core compared to housing in vacation areas, the findings with respect to neighborhood income were also different. As seen in Table 4, hypothesized expectations for housing in higher income neighborhoods to suffer less damage (H_4) and recover more quickly (H_5) found strong support in the urban core, but were rejected in both vacation areas. Figure 4 displays the impact-recovery trajectories for housing in neighborhoods varying by median household income for each area. The income ranges were limited for Bolivar; consequently, only two sets of predicted values, at 30K and 35K, are presented, along with the more extend ranges possible in urban core and island vacation areas. The differences are most evident when comparing housing in urban core versus island vacation areas. In the urban core, the upper trend line reflecting lower impact and more rapid and higher levels of recovery is for housing in higher median income (70K) neighborhoods, while the lowest line representing higher impact, and the slowest and lowest levels of recovery is for housing in the lowest median income (30K) neighborhoods. The other lines fall between these extremes in order. However, in island vacation areas, the trend lines appear in opposite order.

Figure 3- Damage-Recovery Trajectories for Owner-Occupied vs. Other Single Family Housing



The predicted values for each figure were generated employing each sub-market model for owner-occupied and other housing and submarket specific mean values for other independent variables. Predicted values have been exponentiated and indexed relative to 2008 predicted values.

Figure 4- Impact-Recovery Trajectories by Neighborhood Median Household Income



The predicted values for each figure were generated employing each sub-market model for owner-occupied housing with specified income levels and submarket specific mean values for other independent variables. Predicted values have been expotentiated and indexed relative to 2008 predicted values.

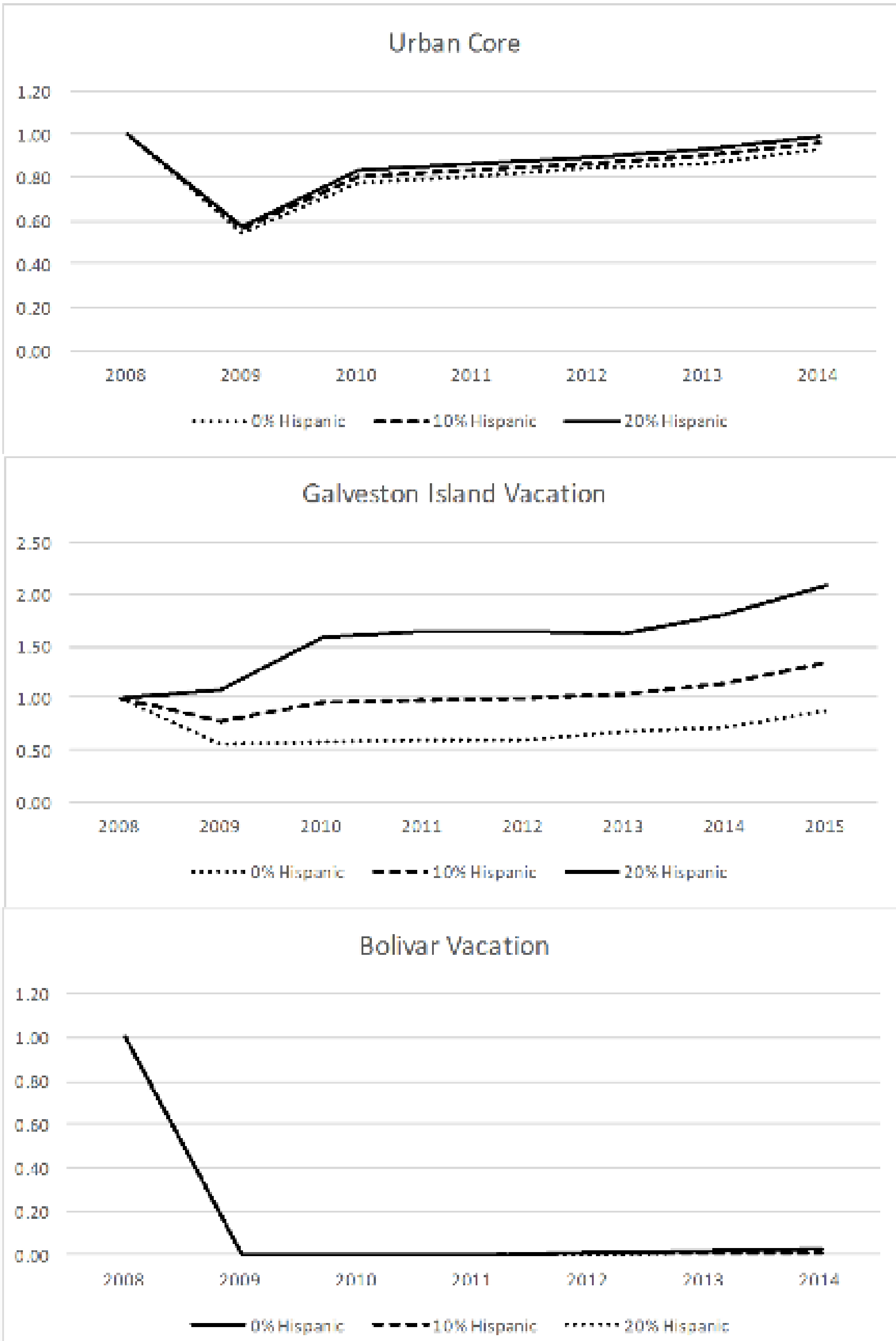
Housing in the lowest income neighborhoods (30K) are represented by the upper trend line, and remaining trend lines fall in opposite order with housing in highest median income areas (70K) suffering higher impacts and recovering slower and at lower levels. While only two sets of predictions were possible for Bolivar, similar to island vacation areas, the upper trend line is for housing in the lowest median income level (30K). Tests for non-linear income effects that may have accounted for this reversal were not significant.

Two plausible explanations for the opposite findings with respect to income might be related to Galveston's unique development patterns between its urban core and vacation areas and a specification issue stemming from using census data to capture household characteristics. Galveston, as noted above, has more or less clearly defined residential and vacation areas. The former is located in the historical core of the community, to a large extent behind its historic seawall, with historic and higher income housing located on land elevated behind and closer to the seawall. Many lower income areas are located closer to the bay side of the island that were not as elevated and were subject to higher levels of flooding as Ike's surge came around the island from the bay side. Hence, these factors result in higher income areas experiencing less damage, and given normal recovery processes for single-family housing, homes in higher income areas recovered more quickly. In vacation areas, on the other hand, the goal is to have vacation and second homes as close to the coast as possible, which means higher valued properties potentially with a few wealthier year-round residents were more vulnerable to and suffered higher levels of damage. Housing more distant from the water may well be lower valued and more likely occupied by lower income year-around residents. Hence, the negative relationship with respect to damage implies higher recovery levels for lower income areas, assuming that higher owner occupancy rates means greater access to recovery resources and quicker decisions to rebuild/repair. It is possible that the negative findings for Galveston's vacation areas are partially a function of employing census data to, in part, capture the household characteristics of housing occupants. In the urban core, census data is likely to better capture the characteristics of full time residents (both renters and owners), while in vacation areas, the correlation is more tenuous because the actual owners of vacation and second homes are not full time residents that would be included in census data. For example, the correlation between appraised housing value and median household income was .37 in the urban core but only .09 in island vacation areas, suggesting this more tenuous relationship between census data and actual occupants/owners of housing in these areas. Future research utilizing primary data on household income, structure specific data on vacation or secondary home status, along with detailed data on proximity to coast and actual flood depths can perhaps address this issues. For now, the theoretical expectations of a negative relationship between income and impact and a positive relationship between income and recovery only found support in traditional residential areas where year around community residents are likely to be the majority. What is equally clear, however, is that widely different impact and recovery patterns are evident with respect to income when comparing housing located in residential versus vacation areas.

The findings with respect to neighborhood minority concentrations among Galveston's housing submarkets were perhaps the most surprising and unexpected. The expectations were that housing in neighborhoods with higher minority concentrations would suffer higher levels of damage (H_6) and would recover more slowly (H_7). Since the authors examined minority concentrations for both Hispanic and non-Hispanic Black composition, the findings for each are presented separately as a set of rows. The results are mixed at best, but on the whole the finding for Hispanic concentrations are strongly negative with respect to the hypotheses, and the fact that hypotheses for both Hispanic and non-Hispanic Blacks are rejected for housing in Galveston's residential urban core is also a strong negative finding. Figure 5 employs a set of Hispanic concentrations common to all three areas. In both the urban core and island vacation areas, housing in neighborhoods with higher Hispanic concentrations suffered less damage and displayed steeper more positive recovery trajectories. The only finding consistent with the hypothesized expectations for Hispanic concentrations is found in the recovery trajectories on Bolivar, where housing in areas with lower Hispanic concentrations performed significantly better, but that is against a context of simply very, very limited recovery for all housing on Bolivar in the first place. Figure 6 also employs a common set of non-Hispanic Black concentrations for the urban core and island vacation areas. The results for housing in the urban core, again, run completely counter to the hypotheses in that housing in neighborhoods with higher concentrations of non-Hispanic Blacks suffered lower impacts and display stronger and more positive recovery trajectories. These patterns are however, reverse among housing in island vacation areas where neighborhoods with higher non-Hispanic Blacks suffered disproportionately more negative impacts and display very shallow, almost flat "recovery" trajectories until 2013 or 2014.

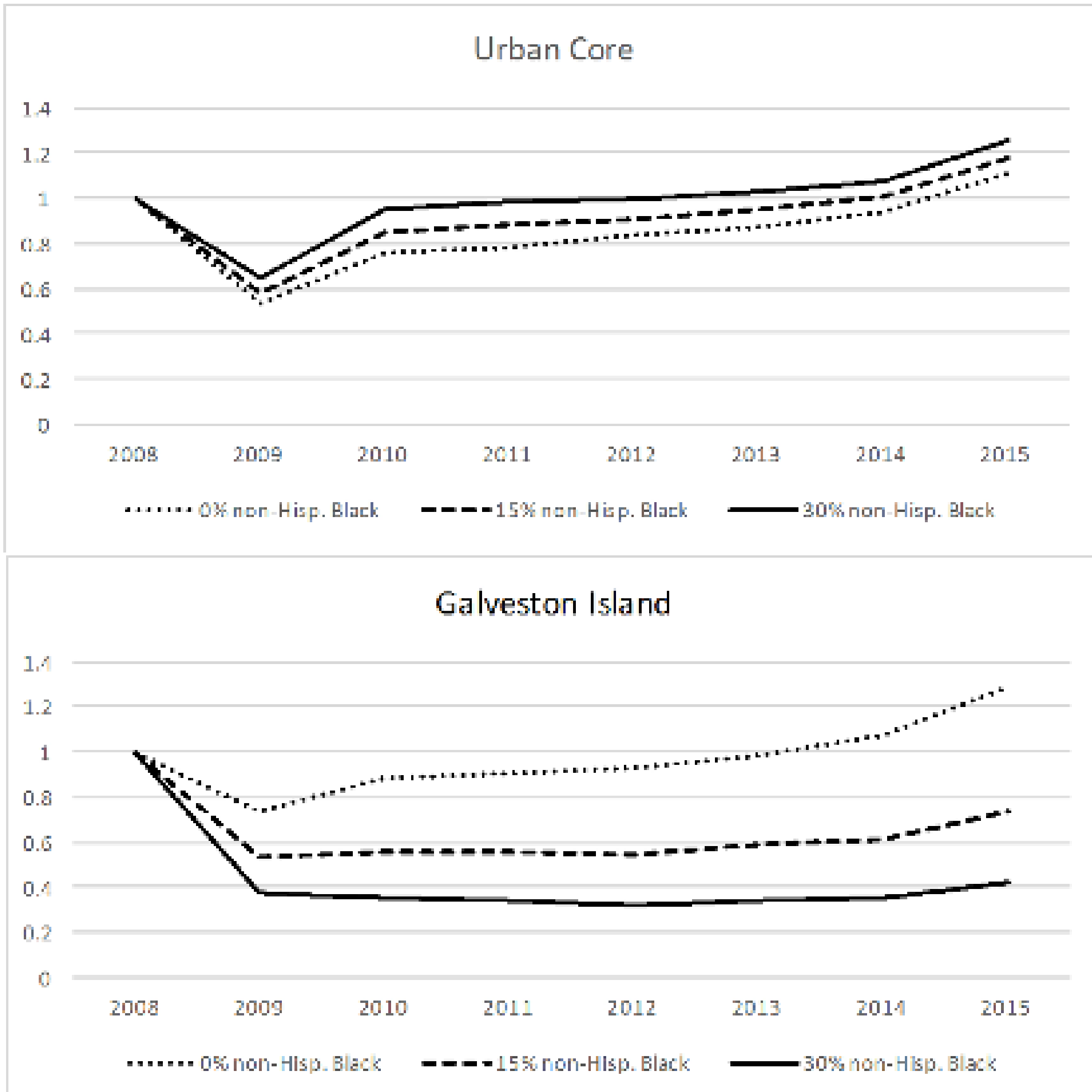
The rejection of hypotheses for both Hispanic and non-Hispanic Black neighborhood composition factors in Galveston's more traditional urban core residential area is particularly intriguing because it runs counter to the literature that has generally focused on typical residential housing markets, not the special case of vacation housing markets. It should be noted that interaction effects between income and neighborhood minority composition, attempting to account for the unanticipated findings with respect to income and minority composition were explored, but did not prove fruitful. Another factor is related to the highly significant, negative,

Figure 5- Impact-Recovery Trajectories by Neighborhood Hispanic Composition



The predicted values for each figure were generated employing each sub-market model for owner-occupied housing with specified income levels and submarket specific mean values for other independent variables. Predicted values have been exponentiated and indexed relative to 2008 predicted values.

Figure 6- Impact-Recovery Trajectories by Neighborhood non-Hispanic Black Composition



The predicted values for each figure were generated employing each sub market model for owner occupied housing with specified income levels and submarket specific mean values for other independent variables. Predicted values have been exponentiated and indexed relative to 2008 predicted values.

and long lasting consequences of damage and the resulting relatively flat recovery trajectories found throughout the examples displayed in Figures 2-6. In other research that quantitatively examines housing recovery, the trajectories are generally steeper, suggesting trends that are more consistent with expectations that housing will recover in 2 to 5 years (Bin & Kruse, 2006; De Silva, Kruse, & Wang 2006; Zhang & Peacock 2010). However in this research, trajectories reflect a much longer recovery period clearly indicating low levels of reinvestment for the rebuilding and repairs necessary for robust housing recovery. This is perhaps due to the fact that Ike struck in 2008, the peak of our nation's economic meltdown, but the authors also know that many households reported having difficulties obtaining insurance settlements because of disagreement as to whether damage was wind or flood related (Hamideh, 2015). Survey work also suggests that 50% of homeowners did not have flood insurance and many houses had to be elevated to meet flood requirements, substantially adding to rebuilding costs (Van Zandt et al, 2012; Peacock et al 2014 and 2017). The city was able to obtain CDBG-Recovery funding, which must partially target low income households and areas, to directly help homeowners and some rental properties rebuild. The literature also suggests that social capital can be important for long-term housing recovery particularly in the context of relatively low economic capital (Aldrich and Meyer 2015; Aldrich 2012). It may well be that these factors have helped shape the unanticipated findings with respect to both the minority composition and income in the post-Ike housing recovery process.

The discussion above clearly points to fruitful areas of future research and a major limitation in this study as well as most recovery research to date. To more fully understand recovery in general and housing recovery in particular there is a need to move beyond single case study events and develop relatively large longitudinal datasets that include individual/household level data on recovery resources such as inputs from private and public insurance, aid, grants, and loans from federal, state, and local sources, as well as inputs from social networks (Peacock et al., 2008). Unfortunately, without primary data collection and cooperation from state and federal sources, the development of these datasets will be difficult.

Recommendations and Conclusions

Comparing the drops for respective damage levels across each area, it is clear that vacation areas experienced greater damage, and these areas don't bounce back as quickly as year-round residential areas. Overall, findings of this study suggest that housing recovery policy for places with a tourist-based economy, with large seasonal submarkets, should take into account the differences in the nature of the decisions to repair and rebuild between owners of year-round and seasonal homes. Recovery assistance programs for such communities would also benefit from allocating a wider range and higher levels of resources and financing options to support repairs and rebuilding for seasonal, second, and occasional housing. Considering disparate decisions and making resources available are particularly important in order to support recovery of seasonal homes with higher levels of damage in vacation areas because they present very slow recovery trajectories which can hold back recovery of the local economy as well.

Indeed, relatively lower levels of damage among single-family houses in the island vacation areas that were built with stronger building codes demonstrates the effectiveness of mitigation for accelerating recovery. Had damage levels been as high in the island vacation areas, Galveston's tourist based economy would have been truly devastated, and the slow recovery it experienced may not have happened at all. The overall consequences of damage for recovery across all areas, particularly in the vacation markets where recovery resources are more limited, drives home the need for coastal communities to reduce damage and enhance resilience through stronger building codes, ensuring properties are properly elevated, and enhancing free-board requirements.

The recovery differentials observed between owner-occupied and renter-occupied homes in both year-round and vacation areas are clearly consistent with observations first highlighted by Comerio (1997, 1998) and more recently acknowledged by FEMA (2009 and 2011) that our nation's recovery policies focus on owner-occupied housing and neglect rental housing. The authors must add to these failures in single-family rental housing, the delays and recovery failures for multi-family rental housing in general (Bolin and Stratford 1998; Peacock Dash and Zhang 2006; Peacock et al., 2017) and in Galveston following Hurricane Ike (White 2010; Hamideh 2015). Clearly, our nation needs to grapple with the problem of rental housing recovery. Recent changes and added flexibility to HUD's CDBG-Recovery funding (Olshansky and Johnson, 2014) may provide an opportunity for local communities to work with HUD to put into place funding mechanisms that might potentially address part of this issue.

The negative relationship between income and impact and the positive relationship between income and recovery we found in traditional residential areas highlight a need for income-targeted housing recovery assistance in areas where year-round residents are the majority in order to address the needs of lower income households anticipated by our results. However, income may not be the most effective recovery resource allocation standard for supporting recovery in vacation areas based on their widely different and unexpected impact and recovery patterns observed with respect to income.

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Figure Captions

Figure 1. Vacation homes by census tract

Figure 2. Impact-Recovery Trajectories by Damage Levels

Figure 3. Damage-Recovery Trajectories for Owner-Occupied vs. Other Single Family Housing

Figure 4. Impact-Recovery Trajectories by Neighborhood Median Household Income

Figure 5. Impact-Recovery Trajectories by Neighborhood Hispanic Composition

Figure 6. Impact-Recovery Trajectories by Neighborhood non-Hispanic Black Composition

Table 1. Weighted Housing Unit Characteristics for Galveston: Residential and Seasonal/Vacation Housing Markets

Housing submarkets	Percent Total Housing Units			Percent Vacant for Seasonal, Recreational, or Occasional Use	Percent of Housing Units built			
	Owner-occupied	Renter-Occupied	Vacant		After 1990	1980-1989	1979-1950	Before 1950
Residential market								
Urban Core	33.3	41.9	24.9	16.8	7.5	14.5	41.7	36.3
Seasonal vacation market								
Galveston Island	30.0	15.4	54.6	72.1	24.0	25.8	43.9	6.3
Bolivar Peninsula	22.8	7.5	69.8	79.2	7.6	20.2	60.8	11.4
Total	31.6	33.8	34.6	45.5	10.2	17.0	32.5	40.4

*Estimated housing units: Bolivar 4,408 (10.8%), Island Vacation 6,587 (16.2%), Urban Core 29,655 (73.0%);
Number of census tracts: Urban Core 19, Bolivar 1, Island 3. Data from 2005-2009 American Community Survey.

Table 2. Descriptive statistics for variables in the panel models

Variable	**Description**	**Data source**	***Urban Core***	***Island Vacation***	***Bolivar Vacation***
			Mean (SD)	***Mean (SD)***	***Mean (SD)***
$Ln(AV)_{base}$	Natural log of base year assessed value, 2008	Tax appraisal	11.2137 (.7025)	11.8381 (.6831)	10.9802 (.8884)
$Ln(AV)_{yr1}$	Natural log, assessed value yr. 1 after Ike 2009		10.6366 (1.3996)	11.3690 (1.7031)	3.9812 (5.1174)
$Ln(BV)_{yr2}$	Natural log, assessed value yr. 2 after Ike, 2010		10.9662 (1.5793)	11.5296 (1.9169)	4.2758 (5.3371)
$Ln(BV)_{yr3}$	Natural log, assessed value yr. 3 after Ike, 2011		10.9730 (1.6396)	11.4871 (2.1443)	5.0478 (5.5561)
$Ln(BV)_{yr4}$	Natural log, assessed value yr. 4 after Ike, 2012		10.9715 (1.6734)	11.5239 (2.1799)	5.5763 (5.6970)
$Ln(BV)_{yr5}$	Natural log, assessed value yr. 5 after Ike, 2013		10.9849 (1.7068)	11.5742 (2.1931)	5.9686 (5.7221)
$Ln(BV)_{yr6}$	Natural log, assessed value yr. 6 after Ike, 2014		11.0114 (1.7532)	11.6209 (2.2051)	6.1917 (5.7299)
$Ln(BV)_{yr7}$	Natural log, assessed value yr. 7 after Ike, 2015		11.1475 (1.8065)	11.7857 (2.2414)	6.5417 (5.7748)

Age	Home's age base year	Tax appraisal	31.9942 (9.8310)	17.6676 (9.6041)	21.3004 (11.4060)
SqM	Square meter		146.5797 (72.2258)	148.2564 (70.4632)	107.2301 (51.3671)
Own	Owner: 1 = owner-occupied, 0 = otherwise.	Tax appraisal	.5827 (.4931)	.2943 (.4558)	.2266 (.4186)
Dmg	Percentage appraised value lost	Tax appraisal	33.4007 (24.2568)	22.5529 (20.3498)	72.8360 (43.6046)
Inc	Median household income (in thousands)	American Community Survey block group	38.6572 (17.9067)	56.7119 (12.0134)	33.2716 (1.3517)
Hisp	Percent Hispanic		31.4043 (18.3886)	7.2020 (4.6217)	5.3638 (7.0922)
Blk	Percentage non-Hispanic Black		18.4410 (18.6648)	1.9997 (7.1034)	0 (0)

Table 3. Panel Models for Each Submarket

Variables		***Urban core***		***Island Vacation***		**Bolivar Vacation**	
	Intercept	10.7050**	11.1225**	11.6545**	11.4186**	28.6760**	13.2943**
Year indicator dummies	Post-Ike yr. 1	0.1499**	0.1594**	0.8958**	0.9401**	0.4339**	10.2140**
	Post-Ike yr. 2	0.5187**	0.0410^{ns}	1.0809**	1.1492**	0.8908**	13.7261**
	Post-Ike yr. 3	0.5438**	-0.0056^{ns}	1.0577**	1.3779**	1.7420**	17.9190**
	Post-Ike yr. 4	0.5666**	0.0330^{ns}	1.1111**	1.3337**	2.3420**	20.9837**
	Post-Ike yr. 5	0.6018**	0.0274^{ns}	1.1839**	1.5847**	2.8057**	23.8607**
	Post-Ike yr. 6	0.6517**	0.0443^{ns}	1.2483**	1.6298**	3.0890**	24.7039**
	Post-Ike yr. 7	0.8113**	0.2443**	1.4327**	1.8109**	3.4489**	25.7894**
House characteristics	Age	-0.0203**	-0.0202**	-0.0189**	-0.0180**	-0.0515**	-0.0525**
	Square meter	0.0053**	0.0053**	0.0054**	0.0054**	0.0051**	0.0053**
Damage and damage-year dummy interactions	Damage	-0.0209**	-0.0324**	-0.0584**	-0.0573**	-0.1011**	-0.1231**
	Damage×yr.2	-	0.0106**	-	-0.0007^{ns}	-	0.0070**
	Damage×yr.3	-	0.0110**	-	-0.0060*	-	0.0192**
	Damage×yr.4	-	0.0127**	-	-0.0055$^{@}$	-	0.0269**
	Damage×yr.5	-	0.0136**	-	-0.0023^{ns}	-	0.0337**
	Damage×yr.6	-	0.0147**	-	-0.0030^{ns}	-	0.0375**
	Damage×yr.7	-	0.0147**	-	-0.0028^{ns}	-	0.0414**
Owner-occupied and Owner-year dummy interactions	Owner occ.	0.2605**	0.1366**	0.0221^{ns}	-0.0692**	0.2262*	0.0783**
	Owner×yr.1	-	0.0678**	-	0.1136**	-	0.0698^{ns}
	Owner×yr.2	-	0.1085**	-	0.0706*	-	0.0219^{ns}
	Owner×yr.3	-	0.1349**	-	0.1411**	-	-0.0304^{ns}
	Owner×yr.4	-	0.1509**	-	0.0856*	-	0.2734$^{@}$
	Owner×yr.5	-	0.1674**	-	0.0824$^{@}$	-	0.2446$^{@}$
	Owner×yr.6	-	0.1886**	-	0.1015*	-	0.3691*
	Owner×yr.7	-	0.1747**	-	0.1003*	-	0.3532*
Median Household income and Median Income-year interactions	Med.H.H.Inc.	0.0067**	0.0025**	-0.0087**	-0.0004^{ns}	-0.5084**	-0.0492**
	Med.Inc.×yr.1	-	0.0034**	-	-0.0053**	-	-0.2505**
	Med.Inc.×yr.2	-	0.0048**	-	-0.0072**	-	-0.3538**
	Med.Inc.×yr.3	-	0.0058**	-	-0.0098**	-	-0.4767**
	Med.Inc.×yr.4	-	0.0051**	-	-0.0087**	-	-0.5667**
	Med.Inc.×yr.5	-	0.0050**	-	-0.0116**	-	-0.6519**
	Med.Inc.×yr.6	-	0.0052**	-	-0.0112**	-	-0.6766**
	Med.Inc.×yr.7	-	0.0046**	-	-0.0109**	-	-0.7050**
Percent Hispanic and Percent Hispanic-year interactions	%Hispanic	-0.0015**	-0.0044**	0.0385**	0.0006^{ns}	-0.0345**	-0.0081**
	%Hisp×yr.1	-	0.0030**	-	0.0334**	-	0.0411**
	%Hisp.×yr.2	-	0.0036**	-	0.0507**	-	0.0153*
	%Hisp.×yr 3	-	0.0038**	-	0.0510**	-	-0.0159*
	%Hisp.×yr.4	-	0.0031**	-	0.0508**	-	-0.0384**
	%Hisp.×yr.5	-	0.0035**	-	0.0447**	-	-0.0549**
	%Hisp.×yr.6	-	0.0031**	-	0.0464**	-	-0.0655**
	%Hisp.×yr.7	-	0.0031**	-	0.0437**	-	-0.0701**
Neighborhood % non-Hispanic Black	%N-Hisp. Blk	-0.0009^{ns}	-0.0060**	-0.0390**	-0.0115**	-	-
	%N.H.B.×yr.1	-	0.0062**	-	-0.0221**	-	-
	%N.H.B.×yr.2	-	0.0078**	-	-0.0307**	-	-
	%N.H.B.×yr.3	-	0.0076**	-	-0.0323**	-	-
	%N.H.B.×yr.4	-	0.0057**	-	-0.0355**	-	-
	%N.H.B.×yr.5	-	0.0052**	-	-0.0348**	-	-
	%N.H.B.×yr.6	-	0.0045**	-	-0.0366**	-	-
	%N.H.B.×yr.7	-	0.0042**	-	-0.0375**	-	-
	R^2 within	0.0857	0.1063	0.1809	0.1923	0.4980	0.5295
	R^2 between	0.3137	0.3137	0.4618	0.4619	0.6058	0.6060
	R^2 overall	0.2591	0.2641	0.4014	0.4038	0.5655	0.5774

Note: urban core: *n*=97,888 in 12,236 groups; Island Vacation: n=48,264 in 6,033 groups; Bolivar Vacation: n=40,128 in 5,016 groups. Test for heterogeneous effects: urban core: 546.09**, Island vacation: 367.74**, and Bolivar vacation: 1548.94**; ns: not statistically significant; two-tailed probabilities: * $p \leq .05$, ** $p \leq .01$; one-tailed: $^{@}p \leq .05$.

Table 4. Summary of Findings with Respect to Hypotheses

Hypotheses	Urban Core	Island Vacation	Bolivar Vacation
H_1: Higher degrees of **damage** will slow recovery	**Supported:** -3.2% per percentage loss initially and -1.8% by 2015	**Supported:** -5.7% per percentage loss initially, remains constant	**Supported:** -12.3% per percentage loss initially and still -7.9% by 2015
H_2: **Owner-occupied** housing will suffer less damage.	**Supported:** owner occupied retained more (+7%) of its pre-Ike value.	**Supported:** owner occupied retained more (+12%) of its pre-Ike value.	***Rejected:*** *owner occupied retains baseline edge, but did not suffer less damage.*
H_3: **Owner occupied** housing will recover more quickly.	**Supported:** owner occupied housing consistently recovers more quickly, finishing +36.5% above	**Supported, marginally**: owner occupied housing recover more quickly a year or two afterward but gains dissolved later in the recovery period	**Supported:** owner occupied housing makes consistent gains after 2011, finishing +54% above.
H_4: Housing in **higher income** neighborhoods will suffer less damage.	**Supported:** housing in higher income neighborhoods suffered less damage	***Rejected:*** *housing in higher income neighborhoods suffered higher damage levels*	***Rejected:*** *housing in higher income neighborhoods suffered higher damage levels*
H_5: Housing in **higher income** neighborhoods will recovery more quickly	**Supported:** housing in higher income areas recovered more quickly	***Rejected:*** *housing in higher income neighborhoods recovered more slowly*	***Rejected:*** *housing in higher income neighborhoods recovered more slowly*
H_{6a}: Housing in neighborhoods with higher **Hispanic** concentrations will suffer more damage	***Rejected:*** *housing in neighborhoods with higher Hispanic concentrations did not suffer relatively higher losses.*	***Rejected:*** *housing in neighborhoods with higher Hispanic concentrations did not suffer relatively higher losses.*	***Rejected:*** *housing in neighborhoods with higher Hispanic concentrations did not suffer relatively higher losses.*
H_{7a}: Housing in neighborhoods with higher **Hispanic** concentrations will recover more slowly.	***Rejected:*** *housing in neighborhoods with higher Hispanic concentrations made net gains, but total assessed values were still lower.*	***Rejected:*** *housing in neighborhoods with higher Hispanic concentrations made relative gains during the recovery period.*	**Supported:** by 2010 housing in neighborhoods with higher Hispanic concentrations were consistently slower to recover and fell further behind
H_{6b}: Housing in neighborhoods with higher **non-Hispanic Black** concentrations will suffer more damage	***Rejected:*** *housing in neighborhoods with higher non-Hispanic Black concentrations did not suffer relatively higher losses.*	**Supported:** housing in neighborhoods with higher non-Hispanic Black concentrations suffered relatively higher losses.	Not applicable: There is no non-Hispanic Black population on Bolivar.
H_{7b}: Housing in neighborhoods with higher **non-Hispanic Black** concentrations will recover more slowly.	***Rejected:*** *housing in neighborhoods with higher non-Hispanic Black concentrations made net gains zeroing out differential assessments.*	**Supported:** housing in neighborhoods with higher non-Hispanic Black concentrations consistently recovered a significantly lower rates.	Not applicable: There is no non-Hispanic Black population on Bolivar.