A Dynamic Microeconomic Model of Post-Hurricane Katrina Residential Rebuilding: Extended Abstract

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Abstract

This paper examines New Orleans homeowners' post-Hurricane Katrina rebuilding decisions using administrative property assessment data linked by street address to Displaced New Orleans Residents Survey detailed survey responses. Residential rebuilding occurred slowly with greater than one third of residential housing still damaged on the third anniversary of Katrina. To assess alternative potential explanations for observed rebuilding patterns, I estimate a dynamic model of forward-looking households' decisions regarding migration, home sale/repair, and participation in the government's Road Home rebuilding grant program. The model explicitly allows the possibility that some homeowners are unable to borrow cheaply, allowing the estimated model to distinguish a distaste for returning from a lack of affordable financing despite a strong preference to rebuild. With estimates of the model parameters, I will conduct simulations to assess the importance of financing constraints, Road Home grant payments, and labor wage levels for households migration and rebuilding decisions.

1 Introduction

This paper examines New Orleans homeowners' post-Hurricane Katrina rebuilding decisions using administrative property assessment data linked by street address to Displaced New Orleans Residents Survey detailed survey responses. I find that following Hurricane Katrina, residential rebuilding in New Orleans occurred slowly. Greater than one third of homes that were owner occupied prior to Katrina remained damaged on the third anniversary of Katrina and nearly one fifth remained damaged on the fourth anniversary of Katrina.[1] Large disparities between blacks and non-blacks in the rate of home repair emerged during the first three years following Katrina, with about half of the homes of black households remaining damaged on the third anniversary of Katrina compared to about one fifth for non-black households.

To assess the causes of these patterns, I will estimate a dynamic model of forward-looking households' post-Katrina decisions regarding migration, home sale/repair, labor supply, and participation in the government's Road Home rebuilding grant program. Using the estimated model I will address three central research questions.

1. Did the slow rate of residential rebuilding in New Orleans typically reflect a distaste for residence in post-Katrina New Orleans or did a lack of affordable financing prevent many from rebuilding quickly despite a strong preference to do so due to?

2. How were rebuilding decisions altered by the Road Home rebuilding grant program that paid large rebuilding grants following sometimes lengthy administrative delays?

3. How important were expected labor wage levels across locations to rebuilding decisions?

I will estimate model parameters using a Nested Fixed Point maximum likelihood algorithm that recovers the likelihood maximizing parameter vector using data on households' migration, rebuilding, and labor market choices and their decisions regarding participation in the Road Home program. Crucial to addressing each of the three questions, the model explicitly incorporates the possibility that some homeowners are unable to borrow cheaply to finance repairs. With estimates of the model's parameters I will conduct a series of simulation experiments to address these questions in turn.

2 Background

This project contributes to several existing literatures. First, the project contributes to the literatures that examines patterns of post-Katrina dislocation and return migration (Gregory and Sastry, 2010; Fussell, Sastry and VanLandingham, 2010; Groen and Polivka, 2008; Vigdor, 2007). These studies examine cross-sectional data (examples: ACS, CPS, and DNORPS), and find large disparities by race in the probability of returning to New Orleans within the first year following Katrina. The studies with access to pre-Katrina information find that these racial disparities are explained to a large extent by differential exposure to flooding as measured by flood depth at the pre-Katrina residence location. As flood depth is a close proxy for damage to structures (McCarthy, 2006),

[1] See Table 1

this relationship suggests that lost location specific capital and rebuilding costs were significant deterrents to return. These studies also find evidence that those who returned experienced better labor market outcomes than those who did not (Groen and Polivka, 2008; Vigdor, 2007), suggesting that expected future earnings also played an important role in the return migration decision. My analysis exploits access to location and earnings panel data to quantify the relative importance of these two factors and to shed light on the role of the credit market in the decision to return. By modeling the role of up-front rebuilding costs and smoothly accruing labor earnings in a unified framework, I will distinguish between alternative potential explanations for these patterns. This modeling approach builds on a structural migration literature in economics (Kennan and Walker, 2008, 2010a, and 2010b; Bishop, 2008; McCall and McCall, 1987) by explicitly incorporating a role for credit markets and by modeling migration in a post-disaster context.

In addition to better understanding post-Katrina migration decisions, this work is more generally interesting because the alternative explanations for post-Katrina migration and rebuilding patterns suggest different conclusions about the potential effectiveness of space based stimulus policies. During the two years following Hurricane Katrina, Congress approved nearly $100 billion in disaster relief aid to the areas impacted by the storm (CBO, 2007). In addition to direct expenditure on clean-up and infrastructure repair, funds were targeted in ways intended to alter the incentives of individuals and firms in affected areas in order to stimulate economic activity and encourage the return of pre-storm residents. The Road Home program[2] paid rebuilding grants directly to individual homeowners equal to the smaller $\$150,000$ and the value of uninsured storm related home damage (with other less generous grants available for those unwilling to return to the home). The Gulf Opportunity Zone initiative subsidized business investment and hiring using federal tax credits and capital subsidies targeted to firms operating in affected areas. While problems with the *process* of implementing these programs have been widely documented, far less is known about the programs' actual impact on post-Katrina New Orleans. The degree to which evacuees are borrowing constrained has important implications for the relative effectiveness of these two varieties of post-disaster policy interventions. When individuals are borrowing constrained, their behavior is more responsive to an up front return subsidy than to an equally generous (in present discounted value terms) smoothly accruing benefit from higher wages, as one would expect to result from employment or capital subsidies paid to firms. If borrowing constraints are not important, subsidizing labor demand might be preferable on efficiency grounds.

3 Data and Descriptive Regressions

This project relies on two primary data sources. I obtain data describing the post-Katrina experiences of a population representative sample of pre-Katrina New Orleans homeowning households using the Displaced New Orleans Residents Survey data. I supplement these survey data with administrative records on housing sales and annual assessed values for 2005 through 2010 from the Orleans Parish Assessor's Office property database. I use these assessment records to construct measures of remaining home damage at multiple points in time following Katrina. I merge these two

[2]The Road Home program was funded through the a U.S. Department of Housing and Urban Development Community Development Block Grant and administered by the Louisiana Office of Community Development.

data sources by (pre-Katrina) street address to obtain a panel of post-Katrina residential locations and home repair decisions.

The Displaced New Orleans Residents Survey (DNORS) conducted interviews for a random sample of pre-Katrina New Orleans households. First a random stratified random sample of pre-Katrina New Orleans dwellings was drawn. A random sample of pre-Katrina New Orleans residents was obtained by identifying, locating, and interviewing the August 2005 occupants of sampled dwellings. Either one or two adults were interviewed per household depending on the result of random selection process. Respondents were asked about a range of topics related to households' experiences in the months and years following Hurricane Katrina. These topics included the timing and destinations of post-Katrina moves, characteristics of the pre-Katrina dwelling, whether the unit was owned or rented, property damage suffered as a result of Katrina, insurance payments received, the mental and physical health of household members, and the labor market experiences of household members during the year prior to Katrina and during the year prior to the interview. Household interviews were conducted for $1,350$ households of whom 813 owned their home when Katrina struck.

I use DNORS survey responses to construct a full balanced panel of post-Katrina location and housing tenure choices. The panel include measures of labor force participation and earnings prior to Katrina and during the year leading up to the interview (roughly the fourth year following Katrina). I also incorporate standard human capital measures such as age and educational attainment as well as contextual factors that might influence the marginal utility of various locations – examples including the presence of school age children in the household and whether extended family members lived in the evacuation location prior to Katrina. Finally, I use self reports of property damage levels in conjunction with the auxiliary measures from administrative data on property sales and property assessments to construct measures of storm damage and measures of subsequent repairs, and to infer participation in the Road Home Program.

I supplement survey data with administrative data on property sales and assessed property values from the Orleans Parish Assessor's Office property database. I use these data along with survey responses to construct measures of structure damage and repair at times between Katrina and the DNORS interview. I also use these data in conjunction with DNORS survey responses to infer participation in the Road Home program. These data include, for each property, an assessed land value and an assessed improvement value for each year from 2005 to 2010 and a record of previous sales and transfers.

Table 1 provides descriptive tabulations of the sample of pre-Katrina homeowning households and describes rebuilding and return migration patterns within demographic subgroups. Immediate storm related damage was most common among blacks and households in which neither household head held a bachelor's degree. Repair of storm related damage occurred less quickly among blacks, those with less heavily damaged homes, and those with more generous insurance coverage. Notable, each of these gaps appeared to narrow between Katrina's third and fourth anniversaries, perhaps attributable to the payment of Road Home rebuilding grants.

Tables 2 and 3 examine the timing of return and rebuilding in a multivariate context using sequences of linear probability regression models. Table 2 considers the probability of a household

repairing its home within various time windows conditional on the home being damaged at the beginning of each time window. Even after controlling for several confounding factors, blacks were less likely than non-blacks to repair a damaged home during the four years following Katrina. Strikingly though, among those who had not repaired a damaged house by the third anniversary of Katrina, blacks were more likely than non-blacks to repair the damages by the fourth anniversary of Katrina. Table 3 finds patterns in the hazard of returning to the pre-Katrina home that resemble the patterns in the hazard of repairing the pre-Katrina home. Blacks exhibited a significantly lower return hazard than non-blacks during the first two years following Katrina. Between the third and fourth years, the return hazard was higher among blacks than among non-blacks.

4 Methodology

In addition to descriptive analysis, this paper's empirical work centers on specifying and estimating the parameters of a structural economic model of households' post-Katrina decisions regarding migration, home sale/repair, labor supply, and participation in the government's Road Home rebuilding grant program. Estimates of the model's structural parameters will allow simulation of household behavior under counterfactual government policy regimes or if relevant prices (i.e. wages or housing rents) had been different. I will use these results to assess the three research questions discussed above. In this section I describe the model and briefly sketch the estimation routine.

I model the post-Katrina location decisions of a pre-Katrina New Orleans household using a discrete time, finite horizon framework. Periods are indexed by $t = 0, .., T$, where 0 is the period in which Hurricane Katrina struck, and T is the horizon of the household's optimization problem. Each period is four months long. A vector $X(t) = [J(t), H(t), D(t), P(t), A(t)]$ describes the state facing the household at time t; J denotes location, H indicates ownership of the pre-Katrina home, D denotes the damage to the pre-Katrina home measured as a fraction of the home's value, P denotes whether and under which option the household has participated in the Road Home grant program, and $A(t)$ denotes the household's financial assets. A time invariant vector Z describes demographic traits of household members and characteristics of the pre-Katrina home. Households know the prevailing wages and rent levels in New Orleans and the most preferred non-New Orleans location and know housing prices in New Orleans.

Each period t, the household must select the subsequent period's state $X(t+1)$. Several feasibility constraints limit households available options. A household may not re-purchase the home if it has been sold. Once a household has chosen to participate in one of the Road Home program options, the option may not be changed. A household may not reside in the pre-Katrina home if the home has been sold or if it is damaged.

Each period, the household derives (constant relative risk aversion) consumption utility $C(t)^{\omega}/\omega$, derives a utility $B(J(t))$ from local amenities that depend on current residential location, and suffers a utility cost from moving (κ^M) or rebuilding (κ^R) in addition to the pecuniary moving or rebuilding costs. A random shock ϵ is associated with each available choice $X(t+1)$.

$$U\Big(C(t), X(t), X(t{+}1), \epsilon(X(t+1))\Big) \;=\; \frac{C(t)^{\omega}}{\omega} \;+\; B\Big(J(t)\Big) \;+\; \mathbf{1}\Big(J(t) \neq J(t{+}1)\Big)\kappa^{M} + \mathbf{1}\Big(D(t{+}1) < D(t)\Big)\kappa^{R} \;+\; \epsilon\Big(X(t+1)\Big) \tag{1}$$

where $\mathbf{1}(.)$ is the indicator function. Households make decisions each period to maximize the expected present discounted value of per-period utilities, denoted by V.

$$V = E_{\epsilon}\left[\; \sum_{t=0}^{T} \beta^{t}\; U\Big(C(t), X(t), X(t{+}1)\Big) \;\right] \tag{2}$$

where β is a subjective discount factor.

Households face in an intertemporal budget constraint which requires that consumption plus net asset accumulation is equal to income (wage earnings plus the proceeds from home sales or grant payments) minus expenses (home repair costs and rent). The market value of a home P^H depends on its damage level D and intrinsic traits captured in Z like the home's size and the neighborhood in which the home is located. The size and timing of Road Home rebuilding grant payments G depend on the household's participation decision and the initial housing damage level and mimic the actual program rules and payment schedule.

$$\begin{aligned} C(t) \;=\; & \overbrace{W\Big(J(t), Z, \epsilon(t)\Big)}^{\text{wage income}} \;+\; \overbrace{P^{H}\Big(D(t), Z\Big)\Big(H(t) - H(t{+}1)\Big)}^{\text{proceeds from home sale}} \;+\; \overbrace{G\Big(P(t), D(t{=}0)\Big)}^{\text{grant payment}} \\ & -\; \underbrace{R\Big(J(t)\Big)}_{\text{rent payment}} \;-\; \underbrace{P^{H}\Big(D{=}1, Z)\Big)\Big(D(t{+}1) - D(t)\Big)}_{\text{repair costs}} \;-\; \underbrace{\Big(A(t{+}1)/(1+r) \;-\; A(t)\Big)}_{\text{change in asset holding}} \end{aligned} \tag{3}$$

I model the possibility of a borrowing constraint by allowing that the interest rate faced when borrowing is higher than the interest rate faced when saving. That is,

$$\begin{aligned} A(t+1)\Big/(1+r) \;&=\; \begin{cases} A(t+1)\Big/(1+r^{s}) & \text{if } A(t+1) \geq 0 \\ A(t+1)\Big/(1+r^{b}) & \text{if } A(t+1) < 0 \end{cases} \\ r^{b} \;&\geq\; r^{s} \end{aligned} \tag{4}$$

To facilitate standard numerical dynamic programming methods, I assume that the unobserved choice specific utility shocks ϵ are normally distributed and are independent of across choices and across time. The independence of the ϵ shocks allows for a recursive dynamic programming representation.

$$V\Big(X(t),\epsilon\Big) \;=\; \max_{X(t+1)}\left\{U\Big(C(t),X(t),X(t+1),\epsilon(X(t+1))\Big) \;+\; \beta\, V\Big(X(t+1)\Big)\right\} \tag{5}$$

$$V\Big(X(t+1)\Big) \;=\; \text{Emax}_{\epsilon} V\Big(X(t+1),\epsilon\Big) \tag{6}$$

I will estimate these parameters using a variant of Rust's (1987) Nested Fixed Point maximum likelihood algorithm in which an "inner loop" computes a numerical solution to the model and obtains a sample likelihood for observed discrete choices for a given parameter vector and an "outer loop" searches the parameter space for the likelihood maximizing parameter vector. The parameters to be estimated include; the constant relative risk aversion parameter ω, the preferences over locations $B(J,Z)$ as a function of time invariant household traits, the interest rate at which constrained households may borrow r^b, the probability that a household is constrained conditional on time invariant traits, the utility costs κ^M and κ^R to moving and to rebuilding, the variances of the choice specific shocks, and the parameters of the wage offer equation across locations.

With estimates of the model's parameters in hand, I will conduct simulation experiments to address each of the three questions discussed above. If parameter estimates find that a sizeable fraction of households behave as if they are borrowing constrained, I will assess the behavioral importance of those constraints by comparing observed behavior to simulated behavior were those constraints to be relaxed. I will assess the relative importance of grant payments and New Orleans wage levels by comparing the relative migration and rebuilding effects of equivalent present discounted value increases in those two varieties of benefit.

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Table 1: Descriptive Statistics for pre-Katrina Homeowning Households

		Damaged Home if Variable=1				Living in pre-Katrina Home if Variable=1				
Variable	Sample Percentage	Immediate	2 Yr	3 Yr	4 Yr	Immediate	1 Yr	2 Yr	3 Yr	4 Yr
Household Head(s)										
Single Female Headed	35	71	49	41	20	1	30	34	37	57
Single Male Headed	17	64	43	38	20	5	38	43	47	62
Couple Headed	48	66	46	33	17	2	38	42	48	62
Race										
Black	56	83	64	50	24	2	24	28	34	58
non-Black	44	47	24	18	11	3	49	53	56	63
Most Educated HH Head										
H.S. Dropout	11	72	53	45	17	1	37	44	50	72
H.S. Graduate	19	79	57	48	28	3	29	31	34	54
Some College	25	79	57	41	21	3	26	31	38	55
Bachelors+	45	55	36	27	14	2	42	45	49	62
Self Reported Damage										
Still Liveable	33	0	10	8	6	4	71	73	74	76
Unliveable	47	100	58	43	18	2	22	28	35	58
Destroyed	20	100	81	66	39	2	5	8	15	38
Insurance Coverage										
None	32	54	36	28	12	2	44	48	51	63
Some or Half of Damages	43	75	53	40	21	2	30	36	42	59
All or Most	25	74	51	42	23	3	29	31	38	58
Observations	958									

Table 2: Linear Probability Models of Home Repair Hazard

	(1) Repaired Yr 0-4	(2) Repaired Yr 0-2	(3) Repaired Yr 2-3	(4) Repaired Yr 3-4
Race				
non-Black (reference)	-	-	-	-
	-	-	-	-
Black	-0.0695*	-0.274***	-0.0368	0.121*
	(0.038)	(0.044)	(0.056)	(0.071)
Most Educated HH Head				
H.S. Dropout	0.0672	0.0296	-0.0625	0.129
	(0.055)	(0.065)	(0.066)	(0.085)
H.S. Graduate (reference)	-	-	-	-
	-	-	-	-
Bachelor's or more	0.0426	0.0159	-0.00238	0.0165
	(0.039)	(0.042)	(0.048)	(0.064)
Home Damage				
not Destroyed (reference)	-	-	-	-
	-	-	-	-
Destroyed	-0.214***	-0.225***	-0.0808*	-0.178***
	(0.041)	(0.038)	(0.043)	(0.058)
Insurance Coverage				
Uncovered Losses (reference)	-	-	-	-
	-	-	-	-
All or Most of Losses Covered	-0.0376	0.0787*	-0.0572	-0.0668
	(0.041)	(0.044)	(0.045)	(0.062)
Constant	0.858***	0.588***	0.316***	0.488***
	(0.040)	(0.048)	(0.061)	(0.080)
Observations	585	585	403	310

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < .01$

Note: Dependent variables are flags for home being non-damaged on various anniversaries of Hurricane Katrina. Each model is estimated using a sample of homes that are damaged at the beginning of the time window listed in the column label. For example, the column labeled "Repaired Yr 3-4" estimates the probability of a household's pre-Katrina being repaired on the fourth anniversary of Katrina *conditional* on the home being damaged on the third anniversary of Katrina. Source: DNORS and Orleans Parish property assessment data.

Table 3: Linear Probability Models of the Hazard of Returning to Residence in pre-Katrina Home

	(1) Returned Yr 0-4	(2) Returned Yr 0-1	(3) Returned Yr 1-2	(4) Returned Yr 2-3	(5) Returned Yr 3-4
Race					
non-Black (reference)	-	-	-	-	-
	-	-	-	-	-
Black	-0.0112	-0.212***	-0.0136	0.0103	0.212***
	(0.035)	(0.032)	(0.022)	(0.028)	(0.042)
Most Educated HH Head					
H.S. Dropout	0.177***	0.115**	0.0811*	0.0204	0.152**
	(0.047)	(0.051)	(0.044)	(0.046)	(0.076)
H.S. Graduate (reference)	-	-	-	-	-
	-	-	-	-	-
Bachelor's or more	0.0309	0.0213	-0.00868	-0.00138	0.0304
	(0.036)	(0.032)	(0.020)	(0.026)	(0.044)
Home Damage					
not Destroyed (reference)	-	-	-	-	-
	-	-	-	-	-
Destroyed	-0.276***	-0.322***	-0.0497***	-0.0184	-0.0748*
	(0.040)	(0.025)	(0.019)	(0.026)	(0.043)
Insurance Coverage					
Uncovered Losses (reference)	-	-	-	-	-
	-	-	-	-	-
All or Most of Losses Covered	-0.0204	-0.0252	-0.0404**	0.0106	0.00496
	(0.037)	(0.034)	(0.019)	(0.027)	(0.045)
Constant	0.638***	0.516***	0.0920***	0.0831***	0.151***
	(0.037)	(0.035)	(0.023)	(0.027)	(0.044)
Observations	954	954	625	586	538

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < .01$

Note: Dependent variables are flags for one residing in one'pre-Katrina home on various anniversaries of Hurricane Katrina. Each model is estimated using a sample of households who do not reside in their homes at the beginning of the time window listed in the column label. For example, the column labeled "Returned Yr 3-4" estimates the probability of a household residing in the pre-Katrina home on the fourth anniversary of Katrina *conditional* on not residing in the pre-Katrina home on the third anniversary of Katrina. Source: DNORS and Orleans Parish property assessment data.