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Weathering the Storm: Measuring Household Willingness-to-Pay for Risk-Reduction in Post-Katrina New Orleans

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The city of New Orleans suffered extensive damage as a result of Hurricane Katrina. Rebuilding involves decisions on investment in protective measures. An exhaustive list of protective measures has been studied in planning documents, with public comment solicited in town hall meetings. In this study we employ a different approach to examine public sentiment toward the selection and investment in protective measures. Our study uses a stated preference choice experiment with a stratified sample to investigate individuals' willingness-to-pay for rebuilding New Orleans's man-made storm defenses, restoring natural storm protection, and improving evacuation options through a modernized transportation system. We target residents of the New Orleans metropolitan area as well as other U.S. citizens. Our results indicate that individuals are willing to pay for increased storm protection for New Orleans, but values differ among residents of the New Orleans metropolitan area and other U.S. citizens.

JEL Classification: H43, Q51, R53

1. Introduction

Hurricane Katrina made landfall on the Louisiana–Mississippi border of the Gulf Coast on August 29, 2005, leaving behind widespread devastation on the Alabama, Mississippi, and Louisiana coasts. Although the eyewall of Katrina did not pass directly over New Orleans, wind driven waves and storm surge breached several points in the levee system, demonstrating that the city was ill equipped for a storm of Katrina's magnitude. Insufficient artificial and natural storm protection, in conjunction with New Orleans's highly vulnerable physical and human geography, contributed to devastation throughout the city.

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The Louisiana Coastal Protection and Restoration Plan (LACPR 2009) and Mississippi Coastal Improvements Program (MsCIP 2009) were created in response to a U.S. Congressional directive to develop plans for hurricane risk-reduction and coastal restoration in both Louisiana and Mississippi. The LACPR Plan Formulation Atlas considered measures that could be combined to form an exhaustive 200 million alternatives. The final technical report presents four to six alternatives for each of five planning units. The plans consider "Category 5" hurricanes and storm surge resistant levees, the mitigative role of coastal landscapes, livable communities, cultural resources, and risk. Our study investigates a general and limited set of options.

We examine individuals' willingness-to-pay (WTP) to reduce flood risk in New Orleans through application of a stated preference choice experiment. In so doing we offer a different perspective to LACPR in a fairly simple framework. We give a measure of the public will (both national and local) to protect human and physical capital in this vulnerable location. The choice experiment focuses on hypothetical projects that propose funding lines of defense in the form of coastal restoration and Category 5 levees, as well as modernizing existing transportation networks in New Orleans. Through the application of a stratified sampling procedure, we investigate rebuilding preferences for individuals in the New Orleans metropolitan area and U.S. tax-payers in general.

Our results indicate that levee flood protection designed to withstand a Category 5 storm is the most highly valued rebuilding feature. New Orleans metropolitan area residents are willing to pay a substantial amount, while the average U.S. household is willing to pay more. Surprisingly, WTP for coastal restoration was not statistically significant for the New Orleans or U.S. samples but was significant for a model that combines the two samples. A latent class model reveals that households who view coastal restoration as an important part of rebuilding New Orleans and have higher income are willing to pay for coastal restoration, while those that do not see coastal restoration as important and have lower income are not willing to pay. New Orleans metropolitan area residents are willing to pay for modernized transportation in the New Orleans metropolitan area, while the average U.S. household is not. Again, the latent class model reveals some differences in economic value across groups, with higher income U.S. households who view coastal restoration as important harboring a *negative* WTP for improvements in transportation.

2. Background

In the aftermath of Hurricane Katrina, the public has been forced to make difficult decisions concerning how to rebuild. The geographic and social vulnerabilities of New Orleans contribute to the complexity of determining how government will allocate public funds for rebuilding. There was an estimated $10 billion in damage to roads, bridges, and the utility system in New Orleans alone. In Orleans Parish, 134,344 housing units (71% of the housing stock) were damaged, making rebuilding no small feat. New Orleans borders water on three sides, making protection a significant task. Also, much of New Orleans lies below sea level, essentially making the city a bowl between Lake Pontchartrain and the Mississippi River. When the levees fail, as they did after Katrina, this bowl can fill up, leaving much of the city underwater. New Orleans relies heavily on a system of levees and pumps that hold back Lake

Pontchartrain and the Mississippi River and remove water when it enters the bowl.[1] Clear evidence of this vulnerability is the 27 major flooding disasters that have occurred in New Orleans over its roughly 300-year history (Kates et. al 2006).

During Katrina, over 80% of New Orleans was flooded, largely as a result of failed levees. A preliminary analysis by the University of California at Berkeley and the American Society of Civil Engineers determined that these levees failed before they were overtopped, indicating design failure (Seed et al. 2006). The potential damage from a major hurricane had received considerable attention from the media and academics prior to Katrina.[2] Unfortunately, there was insufficient political will to heed these warnings and protect the city in time. The existing system did not perform up to its projected Category 3 storm-protection standard.

There are a number of reasons why federal, state, and local governments failed to adequately fund levees and other flood protection measures. The U.S. Army Corps of Engineers faced cost increases and design changes stemming from technical issues that limited their ability to fund new construction projects. A Corps fact sheet from May 2005 stated that the appropriated funds for fiscal year 2005 were insufficient to cover new construction projects, including levee enlargement to enhance protection in the New Orleans metropolitan area. In addition, socio-political issues, including environmental concerns, legal challenges, and local opposition to some aspects of the flood management plan, complicated initiation and completion of some projects (U.S. GAO 2005). The contentious environment surrounding levee maintenance and augmentation combined with the high price tag limited initiative to address flood hazard in New Orleans, not only for President Bush but also previous administrations. Kunreuther and Pauly (2006) refer to this phenomenon as the not in my term of office syndrome.

In addition to man-made structures, natural coastal features such as wetlands and barrier islands provide additional storm protection for coastal regions. Previous estimates from Hurricane Andrew suggest that a kilometer of coastal marsh can reduce storm surge by roughly 7.9 cm (Lovelace 1994). Louisiana has experienced significant losses of coastal wetlands. Hurricanes Katrina and Rita destroyed 217 square miles of coastal wetlands in a single season. The destruction of coastal wetland in the New Orleans area due to the single event of Katrina would normally be expected to take a span of 50 years (LACPR 2009). While flooding from Katrina was largely the result of failed levees, degraded coastal wetlands played a significant role in the disaster.

The degradation of Louisiana's coastal environment stems from individual and government action at various levels within the Mississippi River basin. Kousky and Zeckhauser (2006) term the associated losses in ecosystem services as JARing actions (where JAR stands for jeopardized assets that are remote). The construction of levees, jetties, and canals in the Mississippi River basin significantly changed sediment transport in the system. Alterations in sediment transport have starved wetlands (Turner 1997). In addition, land subsidence, either

[1] The state's levee system was founded in the Louisiana constitution, which created local levee and drainage districts to build and maintain levees. Since Katrina, class action suits have been brought against the Orleans Levee District, the Lake Borgne Basin Levee district, the East Jefferson Levee District, and their respective boards of commissioners, as well as the U.S. Army Corps of Engineers.

[2] Between June 23 and 27, 2005 the *New Orleans Times-Picayune* ran a series entitled "Washing Away" that was critical of federal, state, and local government flood risk management in south Louisiana. The vulnerability of New Orleans was also mentioned in the U.S. Commission for Ocean Policy, as well as in a *Scientific American* piece titled "Drowning New Orleans" (Fischetti 2001).

naturally or due to hydrocarbon extraction, and rising sea levels threaten low lying coastal areas (Morton et al. 2002). Decreased sediment flow and resource extraction have imposed external costs on New Orleans and other Gulf Coast cities in the form of a degraded natural environment and reduced storm protection.

In addition to natural and man-made flood protection, transit and highway infrastructure play a key role in evaluating the vulnerability of coastal populations. The capacity and resilience of transit and highway infrastructure affect how successfully transit can be used in emergency evacuation and disaster response. In a special report, the Transportation Research Board (2008) recommended that "Federal funding should be provided for the development of regional evacuation plans that include transit and other public transportation providers." Further, public transit fills a unique role in providing a mode of evacuation for populations that are transit-dependent and may require special assistance.

3. Preferences for Rebuilding New Orleans

The main purpose of this article is to evaluate individual preferences for the reconstruction of New Orleans. The rebuilding plans constitute a series of local public goods; we estimate individual WTP for these public goods. Since many decisions have yet to be made on restoring New Orleans, we employ hypothetical choice experiments (CEs) to assess preferences for rebuilding. CEs are a stated preference method that can be used to value the characteristics of rebuilding projects. In a CE, subjects are asked to express a preference over several alternatives. Each alternative is characterized by an array of attributes that describe the alternative. The levels of each attribute, for example, the number of acres of wetlands restored under a particular rebuilding plan, can vary across alternatives, and each choice can include a status quo or "no choice" option. The attributes that describe each alternative and the levels that each attribute can take are chosen by the researcher to address the valuation question at hand. By observing respondents' choices over a number of choice sets, we can learn about the tradeoffs individuals are willing to make in terms of a rebuilding plan for New Orleans.

Our principal sample is composed of New Orleans metropolitan area households—the primary beneficiaries of rebuilding efforts. We employ a random digit dialing survey that uses paired comparisons—status quo rebuilding plan versus an alternative that can exhibit improvements in flood control, coastal restoration, and/or transportation infrastructure. The paired comparison approach was deemed necessary because visual aids were difficult to employ with a telephone survey. By focusing on status quo versus an alternative in each choice set, we minimize the amount of information that respondents must process, since the status quo was constant across all choice sets. We use an experimental design that allows us to maximize statistical performance while maintaining task simplicity. In addition to the New Orleans subjects, we also gathered choice data from a sample of U.S. households.

Experimental Design

Our choice experiment investigates rebuilding options using four primary attributes: (i) levee augmentation, (ii) coastal restoration, (iii) transportation system improvements, and (iv) a funding mechanism in the form of a one-time increase in federal income tax payments. As

Table 1. Choice Experiment Design

Attribute	Levels
Levee protection	Category 3 storm (status quo)
	Category 5 storm
Coastal restoration	No (status quo)
	Yes
Transportation system	Conventional (status quo)
	Modernized
One-time tax payment for all U.S. households	\$0 (status quo)
	\$50
	\$150
	\$300
	\$450

Each choice set was a pairwise comparison, with the status quo at zero additional tax offered against an alternative with at least one improvement and a higher tax.

indicated in Table 1, each program attribute has two levels, while the tax attribute has four levels. The initial level of each program attribute is described as the status quo level in order to facilitate the pairwise choice design. Similar to previous work in the environmental literature (Adamowicz, Louviere, and Williams 1994; Adamowicz et al. 1998; Layton and Brown 2000; McGonagle and Swallow 2005; Ladenburg and Olsen 2008), the choice experiment focuses on preferences for public goods—in our case, this is rebuilding or improving public works—rather than preferences for private goods, such as funds for rebuilding private property (which would primarily benefit individual households and businesses). We focus on public projects that decrease existing vulnerabilities (levee augmentation and coastal restoration) or enhance evacuation possibilities (improvements in transportation infrastructure). Examples of conjoint choice sets can be found in Appendix A.

Respondents were given a choice between two levels of flood protection. The *status quo* option was to ensure that all levees were capable of withstanding the wind, waves, and storm surge that would accompany a Saffir-Simpson Category 3 storm. The *alternative* option would fortify all levees to be capable of withstanding the wind, wave action, and storm surge consistent with a Saffir-Simpson Category 5 hurricane.[3] By congressional mandate, the LACPR offers multiple planning options capable of providing this level of protection. As such, we chose to focus on this level of storm protection, which will provide a sense of the magnitude of the maximum benefits that storm protection could provide. This estimate would be an upper bound on other levels of storm protection, all else being equal.

The choice sets include an option for restoration of Louisiana's coastal wetlands. The *status quo* option is no coastal restoration, and the *alternative* is to invest in restoring coastal wetlands. Improvements in coastal wetlands would provide additional protection against hurricane force winds and storm surge. In addition, restoring coastal wetlands would provide for additional environmental benefits, such as fisheries habitat and other ecosystem services. These additional benefits were not noted in the survey, but we suspect that many coastal residents are aware of these additional benefits.

[3] An anonymous reviewer points out that the Saffir-Simpson scale does not directly take storm surge into account, and thus our description of storm protection may be somewhat ambiguous in this regard.

The survey also asked respondents to consider improvements in New Orleans's transportation infrastructure. The *status quo* option entails limited bus service, street cars, and conventional roads. The *alternative* is modernized transportation infrastructure that includes expanded bus and light rail service and improved road networks. The modernized transportation system would provide for improved transit through the city on a day-to-day basis and would enhance the ability of citizens to evacuate in the event of a hurricane.

The payment vehicle was a compulsory, one-time increase in federal income tax payments for *all* U.S. households. The *status quo* was provided at zero additional cost, while the tax payment associated with the *alternative* varied at \$50, \$150, \$300, or \$450 per household. The survey explicitly states that all money raised by this one-time tax would go *directly* to rebuilding projects in New Orleans and restoration projects in coastal Louisiana.

Hypothetical bias is a potential limitation of our CE research method. This bias can arise within a stated preference framework due to the hypothetical nature of the exercise; lacking real incentives for choice, subjects may not be sufficiently motivated to expend cognitive effort to search their preferences. Evidence of hypothetical bias in CEs is mixed (Carlsson and Martinsson 2001; Lusk and Schroeder 2004; Johansson-Stenman and Svedsäter 2008). Lusk and Schroeder (2004) find suggestive evidence that CEs are capable of producing unbiased estimates of marginal willingness-to-pay (MWTP), while there may be bias in estimation of total WTP. There is evidence that hypothetical bias can be attenuated through application of a "cheap talk" script, which focuses respondent attention on the phenomenon of bias and encourages them to respond as if the exercise were real (Carlsson, Frykblom, and Lagerkvist 2005; List, Sinha, and Taylor 2006). We, thus, employ a variant of cheap talk that is similar to the original language in Cummings and Taylor (1999) but shortened to fit within the context of a telephone survey and changed to reflect differences in the nature of the good being valued. The cheap talk script is included in Appendix B.

In applying a CE, the researcher designs the profiles of alternatives that are shown to subjects (i.e., deciding which levels of attributes are to be combined in a single alternative). These profiles and how they are combined define the choice sets that individuals will consider when participating in the experiment, and they determine the matrix of independent variables that are used in analysis of the CE data (described below). As such, the design of profiles influences the efficiency of parameter estimates. With our proposed attributes and levels, a full factorial design has 32 alternative profiles ($2^3 \times 4 = 32$). The full factorial design, however, includes options that would be dominated by the status quo (e.g., status quo conditions at zero vs. positive price). As such we chose only a fraction of the full array of possible profiles, restricting the dominated options from consideration; for our problem, fully efficient designs (i.e., those that minimize variance of parameter estimates) for linear models can be constructed with 8 or 16 alternative profiles. We chose 16 profiles, which represents a fractional factorial design from which main effects can be estimated. We follow Huber and Zwerina (1996) in constructing a linear experimental design that is orthogonal (levels of each attribute vary independently of one another so that attribute levels are not correlated) and balanced (levels of each attribute appear with equal frequency). We employ SAS macros *%MktEx* and *%ChoiceEff* to design an efficient fractional factorial design of 16 pairwise choice sets (Kuhfeld 2010). In all choice sets, the status quo at zero additional tax is offered against an alternative plan that has at least one improvement in program attributes and a higher tax.

Since our econometric model, however, is non-linear we cannot claim that our design is in fact fully efficient (which would require advance knowledge of unknown parameters). Huber and Zwerina (1996) claim that using linear designs for choice experiments is a reasonable approach in situations for which no prior knowledge of parameter estimates is available. In order to lessen the burden on subjects, we use a blocked design of the 16 choice sets, employing only four choice sets per respondent. The *%MktBlock* SAS macro was used to efficiently partition our 16 choice sets into four blocks of four choice sets (status quo vs. alternative). An example of one of the blocks is included in Appendix A. The sequencing of the choice sets within each block was alternated across respondents in order to control for order effects, producing a total of 16 choice sets—four blocks of four choice sets, each with four sequences.

Survey Questionnaire and Administration

Our survey targeted two populations, residents of the New Orleans metropolitan statistical area (MSA) and U.S. residents not in the New Orleans MSA. Each survey had three primary sections, and we estimated it would take between 10 and 15 minutes to administer. We conducted a series of focus groups to pretest the survey instrument. The focus groups were composed of subjects from various racial, ethnic, and socio-economic backgrounds, and individual responses to survey questions were noted and explored in an effort to learn how subjects may interpret questions. The first section of the New Orleans survey elicits information concerning the respondent's family attachment to New Orleans, whether the respondent experienced Hurricane Katrina, and whether this event and the aftermath would influence their decision to stay in the area. The first section includes a series of Likert-scale questions designed to assess the subjects' perceptions of various attributes of the rebuilding plan, including the importance of crime control, housing availability, job creation, flood protection, coastal wetland restoration, improved transportation, and cultural preservation.

For the U.S. survey, the first section gauges individuals' familiarity and experience with New Orleans, in addition to the assessment of perceptions of the importance of rebuilding factors. The second section of the survey administers the choice experiment. Our blocked experimental design offered four choices to each respondent, with subjects choosing either the *status quo* at $0 additional federal taxes per household or an *alternative* scenario that offers improvements in the rebuilding plan in exchange for a one-time payment of additional federal taxes for each U.S. household. Subjects were instructed to treat each choice set as if it were an independent referendum that should be considered in isolation from the other choices. In each survey, we precede the four hypothetical choices with a cheap talk script (see Appendix B). The third part of the survey elicits information on socio-demographic factors, including sex, ethnicity, whether the respondent considers her/himself Latino or Cajun, level of education, employment status, age, income, and household size.

4. Data

Our sample was collected via a stratified random digit dial (RDD) of telephone numbers in the New Orleans MSA and other U.S. households. The survey was administered between May 2007 and June 2008 by individuals in East Carolina University's Community Research Lab. Postcards were sent to mailing addresses associated with the phone numbers, and those returned as undeliverable were eliminated from the sample. Calls were placed, and non-working

Table 2. Descriptive Statistics by Strata

	Obs	NOLA (unweighted) Mean (standard deviation)	NOLA (weighted) Mean (standard deviation)	Obs	United States (unweighted) Mean (standard deviation)	United States (weighted) Mean (standard deviation)
Female	119	0.7395 (0.4408)	0.5788 (0.4958)	215	0.5860 (0.4937)	0.4954 (0.5011)
White	116	0.7155 (0.4531)	0.6154 (0.4886)	214	0.7617 (0.4271)	0.7657 (0.4246)
African American	116	0.2500 (0.4349)	0.3725 (0.4856)	214	0.1822 (0.3869)	0.1518 (0.3597)
No high school	117	0.0684 (0.2535)	0.1433 (0.3519)	216	0.0509 (0.2204)	0.0920 (0.2896)
College degree	117	0.3419 (0.4764)	0.0983 (0.2989)	216	0.3426 (0.4757)	0.2721 (0.4461)
Married	119	0.5630 (0.4981)	0.4933 (0.5021)	212	0.5236 (0.5006)	0.5472 (0.4989)
Income (<15K)	116	0.2500 (0.4349)	0.2111 (0.4099)	122	0.2295 (0.4223)	0.1996 (0.4014)
Income (15–30K)	116	0.3621 (0.4827)	0.1878 (0.3922)	122	0.3443 (0.4771)	0.2250 (0.4193)
Income (>100K)	116	0.0776 (0.2687)	0.1534 (0.3619)	122	0.0246 (0.1555)	0.0793 (0.2714)

This table represents the weighted and unweighted descriptive statistics for the NOLA and U.S. strata.

numbers and ineligible numbers (businesses, fax numbers, etc.) were also eliminated. After this process, there were roughly 500 eligible phone numbers located in the New Orleans MSA. An equal number of eligible phone numbers were located in the rest of the United States.

Successful contact rates were low for the New Orleans MSA; this likely reflects displaced households. Contact was established with 298 households in the New Orleans MSA compared with 355 in the rest of the United States. The final dataset includes information from 128 households in the New Orleans MSA and 220 U.S. households not in the New Orleans vicinity. The corresponding response rates are 25.6% for the New Orleans MSA and 44% for the U.S. sample. Once contact was established with the household, the cooperation rates were 43% and 62%, respectively. Because of incomplete information, only 120 households in the New Orleans MSA and 217 U.S. households not in the New Orleans vicinity are used in the choice models.

The potential biases in all telephone surveys are magnified in the wake of a disaster like Katrina (Galea et al. 2008; Kessler et al. 2008). Neighborhoods housing the poorest, least educated residents usually suffer the most damage and take the longest to recover essential services like telephones. Relocation within the city creates additional challenges. RDD samples help address these issues, but potential bias remains. In an effort to address potential response bias, we develop a weighting scheme to adjust data to match characteristics from the 2006 American Community Survey (U.S. Census Bureau). Our inverse probability weights are based on observable demographic factors—sex, race, Latino status, education level, marital status, and income. Table 2 depicts the weighted and unweighted descriptive statistics for the New Orleans and U.S. strata. We estimate choice models for both strata and combine the strata in order to estimate a single model, applying weights so that the results reflect population proportions.

Table 3. Weighted Frequencies for Importance of Flood Protection

	U.S. Sample		NOLA Sample	
Importance of Flood Protection	Frequency	%	Frequency	%
Not important	7.088	2.64	0	0
Somewhat important	35.250	13.12	2.044	1.55
Very important	224.599	83.62	128.582	97.69
No response	1.646	0.61	1	0.76

This table reports weighted frequencies to correct for non-response.

The average New Orleans respondent had been living in the metropolitan area 41 years, and 76% of households contacted have at least one set of parents from the New Orleans area. Eighty-one percent were in New Orleans just before Hurricane Katrina struck. Thirty-two percent of households have considered leaving New Orleans in the wake of the disaster, with 22% indicating they are very likely or somewhat likely to leave. Turning to the U.S. respondents, about 7% indicated that they have visited New Orleans, and 15% responded that they either visit on a regular basis or plan to visit in the future. Eleven percent of U.S. respondents indicated that they have friends or family in the New Orleans area.

Tables 3–5 report results on individual perceptions of the importance of various factors in the rebuilding plan for the New Orleans and U.S. samples in the form of a weighted frequency table. Our results indicate that individuals in both samples believe that flood protection is very important, but a higher proportion of individuals in the New Orleans sample feel that both coastal wetland restoration and improved transportation are very important.

5. Methods

We use the random utility model (RUM) as a theoretical basis for our choice experiment. We assume that individuals choose rebuilding projects for New Orleans that yield the highest level of utility. Individual n's utility associated with a choice i in choice set t, denoted U_{nit}, is a function of project characteristics, x_{nit}, and associated cost, c_{nit}. Utility can be decomposed into an observable portion, $V_{nit}(x_{nit}, c_{nit}; \tilde{\alpha}, \tilde{\beta})$, and an unobservable portion known only by the subject, ε_{nit}:

$$U_{nit} = V_{nit}(c_{nit}, x_{nit}; \tilde{\alpha}, \tilde{\beta}) + \varepsilon_{nit}, \tag{1}$$

where $\tilde{\alpha}$ and $\tilde{\beta}$ are unknown parameter vectors to be estimated. The probability of individual n choosing a project i over other choice j in set t is, thus,

Table 4. Weighted Frequencies for Importance of Coastal Wetland Restoration

	U.S. Sample		NOLA Sample	
Importance of Coastal Wetland Restoration	Frequency	%	Frequency	%
Not important	34.508	12.85	5.367	4.08
Somewhat important	94.325	35.12	2.130	9.22
Very important	139.750	52.03	113.129	85.95
No response	0	0	1	0.76

This table reports weighted frequencies to correct for non-response.

Table 5. Weighted Frequencies for Importance of Improved Transportation

Importance of Improved Transportation	U.S. Sample		NOLA Sample	
	Frequency	%	Frequency	%
Not important	10.863	4.04	4.768	3.62
Somewhat important	109.772	40.87	36.044	27.38
Very important	145.814	54.29	89.814	68.23
No response	2.133	0.79	1	0.76

This table reports weighted frequencies to correct for non-response.

$$P_{nit} = \Pr[V_{nit}(c_{nit}, x_{nit};\ \tilde{\alpha}, \tilde{\beta}) + \varepsilon_{nit} \geq V_{njt}(c_{njt}, x_{njt};\ \tilde{\alpha}, \tilde{\beta}) + \varepsilon_{njt}]. \tag{2}$$

We assume the observable portion of utility is additive: $V_{nit}(c_{nit}, x_{nit}; \tilde{\alpha}, \tilde{\beta}) = \tilde{\alpha}c_{nit}, + \tilde{\beta}'x_{nit})$.[4] Under the assumption that the error terms in Equation 2, ε_{nit} are independent and identically distributed (i.i.d.) extreme value variates for all n, i, and t, the choice probabilities take the closed-form expression

$$P_{nit} = \frac{\exp(\tilde{\alpha}c_{nit} + \tilde{\beta}'x_{nit})}{\sum_j \exp(\tilde{\alpha}c_{njt} + \tilde{\beta}'x_{njt})}. \tag{3}$$

Under this pooled logit formulation, the multinomial logit (MNL) model can be used to estimate the normalized unknown parameters, $\alpha = \tilde{\alpha}/\sigma$ and $\beta = \tilde{\beta}/\sigma$, where σ is the scale parameter of the extreme value distribution.

It is widely recognized, however, that MNL incorporates taste variation in a potentially restrictive manner, limits substitution patterns, and does not allow for correlation across repeated individual choices. Thus, in our application of RUM, we employ the repeated mixed logit (RXL) model (Train 1998; Herriges and Phaneuf 2002) and the latent class (LC) or finite mixture model (Train 1998; Boxall and Adamowicz 2002), each of which incorporates unobserved individual heterogeneity by allowing the α and/or β parameters to vary within the sample. The variability of utility parameters incorporates taste heterogeneity, provides for more complex substitution patterns, and allows correlation across individual choices.

For the RXL model, the ε_{nit} are i.i.d. extreme value variates for all n, i, and t, and the choice probabilities for any period t are conditional on an individual-specific vector β_n. Including an alternative specific constant for the status quo alternative, the conditional choice probabilities are given by

$$\tilde{P}_{nit}(\psi, \alpha, \beta) = \frac{\exp(\psi d_{nit} + \alpha c_{nit} + \beta_n' x_{nit})}{\sum_j \exp(\psi d_{njt} + \alpha c_{njt} + \beta_n' x_{njt})}, \tag{4}$$

where $d_{njt} = 1$ for status quo, zero otherwise. We assume $\beta_n \sim \phi(\beta \mid \mu, \Omega)$, where ϕ is a multivariate normal probability density with mean μ and covariance matrix Ω.[5] Since our experiment is designed to estimate main effects, we restrict Ω to be diagonal; covariance parameters would only be identified based on assumed functional form. Since ε_{nit} are i.i.d. for

[4] As noted by Train (2003, p. 41), "Under fairly general conditions, any function can be approximated arbitrarily closely by one that is linear in parameters. The assumption is therefore fairly benign."

[5] Other distributional assumptions are possible. For example, the parameters can be sign-restricted by assuming that they follow a log-normal distribution. Since we are attempting to learn about the preferences of individuals, we choose not to impose signs on the parameters and thus employ a normal distribution.

all t, the conditional probabilities for a series of choices $\boldsymbol{i} = \{i_1, \ldots i_T\}$ is given by the product of Equation 4 across choice occasions:

$$\bar{P}_{ni}(\psi, \alpha, \beta) = \prod_{t=1}^{T} \frac{\exp(\psi d_{ni_t t} + \alpha c_{ni_t t} + \beta_n' x_{ni_t t})}{\sum_j \exp(\psi d_{nj_t t} + \alpha c_{nj_t t} + \beta_n' x_{nj_t t})}. \tag{5}$$

Under the formulation of RXL, the unconditional choice probabilities are

$$P_{ni} = \int \bar{P}_{ni}(\psi, \alpha, \beta) \phi(\beta | \mu, \Omega) \, d\beta. \tag{6}$$

The likelihood function is the product of Equation 6 over all individuals in the sample. The means of the ψ and α parameters, as well as the means and variance terms for β, are recovered from simulated maximum likelihood estimates.

The LC model differs from the RXL in that it incorporates unobserved individual heterogeneity through the use of discrete rather than continuous mixing distributions. In this model, it is hypothesized that individual-specific characteristics (s_n) sort individuals into K groups. Each group potentially has different preferences over project choices, so that the probability of Equation 2 conditional on membership in group k is

$$\bar{P}_{nit}^{k} = \frac{\exp(\psi_k d_{nit} + \alpha_k c_{nit} + \beta_k' x_{nit})}{\sum_j \exp(\psi_k d_{njt} + \alpha_k c_{njt} + \beta_k' x_{njt})} \quad \forall k. \tag{7}$$

Since the unobserved errors are i.i.d. extreme values across t, the conditional probabilities for a series of choices $\boldsymbol{i} = \{i_1, \ldots i_T\}$ by type k is given by the product of Equation 7 across choice occasions

$$\bar{P}_{ni}^{k}(\psi, \alpha, \beta) = \prod_{t=1}^{T} \bar{P}_{nit}^{k}. \tag{8}$$

Group membership is unknown to the researcher. The conditional choice probabilities in Equation 8 are weighted by logit probabilities for class membership, which take the form

$$\pi_{nk}(\delta_k) = \frac{\exp(\delta_k' s_n)}{\sum_{h \in K} \exp(\delta_k' s_n)}, \tag{9}$$

where the vector s_n contains demographic variables that influence class membership according to unknown parameters δ_k. Identification requires that parameters for one $k \in K$ are normalized to zero. The unconditional probability for a series of choices by individual n is obtained by a weighted sum of Equation 8 over the k groups, where the weights are given by Equation 9:

$$P_{ni} = \sum_{k \in K} \pi_{nk}(\delta_k) \times \bar{P}_{ni}^{k}(\psi, \alpha, \beta). \tag{10}$$

The parameters of the model in Equation 10 are estimated by maximum likelihood.

We use compensating variation (CV) to measure the incremental welfare change, also known as marginal willingness-to-pay (MWTP), associated with program attributes for rebuilding New Orleans. Conditional on β_{nj}, CV for a rebuilding program attribute j is defined as

$$CV_{nj} = \frac{\Delta x_j \left(\beta_{nj}\right)}{-\alpha}, \tag{11}$$

for each j element of the vector x. Given the discrete nature of program attributes, $\Delta x_j = 1$. For the RXL model, Equation 11 is simulated for all n respondents by taking R draws from the posterior distribution of β, calculating CV, and averaging across the R calculations. For the LC model, Equation 11 is calculated for each of the k segments (replacing β_{nj} with β_{kj}). Mean CV can be calculated as the weighted average across segments, where the weights are given by Equation 9. The Krinsky-Robb procedure (1986) is used to produce standard errors of CV. Krinsky-Robb is a parametric bootstrap method that takes random draws from the multivariate normal distribution of parameters using information from the vector of estimated parameters and the variance–covariance matrix. In our application we take 10,000 random draws in order to develop both 90% and 95% confidence intervals of MWTP.

6. Results

The RUMs are estimated using Matlab and NLOGIT (Greene 2007).[6] We estimate three models using the RXL estimator, corresponding with New Orleans, United States, and combined datasets. Each model includes dummy variables for projects with Category 5 levees, coastal restoration, and modernized transportation system. For the U.S. and combined models, all of these parameters are assumed to be drawn from a normal distribution with diagonal covariance matrix. For the New Orleans sample, the coefficient for the Category 5 levee and modernized transportation are assumed fixed; estimated standard deviations for these parameters under the assumption of normality were not statistically significant.[7] The coefficients for the alternative specific constant representing the *status quo* option and the tax variable are assumed fixed. Models were estimated using maximum simulated likelihood based on 1000 Halton draws.[8] Table 6 presents the parameter estimates for RXL choice models.

In each of the three models, the constant representing the status quo is not statistically significant. As anticipated, the coefficient on the one-time tax increase is negative and statistically significant at 0.1% chance of a type I error in each model. For each model, the coefficient representing Category 5 levees is positive, implying that individuals prefer projects that implement the maximum level of storm protection. Each coefficient representing Category 5 levee protection is statistically significant at the 1% level. Among project attributes, Category 5 levee protection has the largest coefficient, indicating that the average individual believes this project attribute is important relative to other program attributes. Under the assumption of normality, the standard deviation for this coefficient suggests that most individuals exhibit positive preferences for this attribute, but significant preference heterogeneity does exist for U.S. and combined models.

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[6] The mixed logit was estimated using code written by H. Allen Klaiber for the "Micro-Econometrics In and Out of Markets: A Second Training Workshop on Micro-Econometrics in Environmental Economics." This workshop was developed and funded by the Center for Environmental and Resource Economic Policy (CEnREP) at North Carolina State University and the U.S. Environmental Protection Agency.

[7] While the standard likelihood ratio test is biased toward accepting the null hypothesis of zero standard deviation of coefficients, the results are suggestive, and given the complexity of the model and the small sample size for NOLA we find it useful to restrict the model.

[8] See Train (2003) for a discussion of using Halton sequences to draw from densities in mixed logit models.

Table 6. Repeated Mixed Logit Models

	New Orleans	United States	Combined
Status quo	0.5324	0.3663	0.7076
	(0.3989)	(0.4026)	(0.4028)
Category 5	1.3801***	3.4436***	2.9463***
	(0.2957)	(0.6981)	(0.5836)
Category 5 standard deviation	—	3.3284***	2.0667***
	—	(0.7477)	(0.6571)
Coastal restoration (CR)	0.5177*	0.5845	0.6755
	(0.3088)	(0.3682)	(0.4562)
CR standard deviation	1.6057***	2.4609***	2.6503***
	(0.5096)	(0.6770)	(0.7274)
Modern transportation (MT)	0.6295**	0.5507	0.6778*
	(0.2766)	(0.3420)	(0.3495)
MT standard deviation	—	1.5446***	1.3564*
	—	(0.6650)	(0.7155)
Tax	−0.0046***	−0.0068***	−0.0066***
	(0.0007)	(0.0014)	(0.0014)
Individuals	120	217	336
Observations	480	868	1347
Null ln likelihood	−497.355	−765.094	−1775.89
ln likelihood	−345.7521	−465.5882	−1523.98
Halton draws	1000	1000	1000

Standard errors are in parentheses. Mixing distribution assume normality.
*** Statistical significance for 1% chance of type I error.
** Statistical significance at 5%.
* Statistical significance at 10%.

In allowing for a random parameter for coastal restoration, the standard deviation was found to be statistically insignificant for the New Orleans model. Employing a fixed coefficient, the mean utility effect for coastal restoration in the New Orleans models is statistically significant (at the 10% level), and we estimate a positive parameter. Results for U.S. and combined models suggest that utility values for coastal restoration encompass both negative and positive values. The mean coefficient for coastal restoration is not statistically significant in these models, but the standard deviations are statistically significant at the 1% level. We interpret these results as indicating that some individuals in the broader population value coastal restoration while others perceive it as something that should not be funded through general taxation.

The coefficient for modern transportation is positive in each model but statistically significant only for the New Orleans (5% level) and combined (10% level) estimates. Since variability in the random parameter was not statistically significant, the New Orleans model is estimated with a fixed parameter. The estimated mean effects for New Orleans and combined model are positive, as expected. In the combined and U.S. samples the standard deviations for the distribution of coefficients for modern transportation are statistically significant at the 10% and 5% level, respectively. Much like coastal restoration, results from the combined and U.S. samples indicate that some individuals favor rebuilding projects with modernized transportation while others favor projects without it.

In an effort to investigate determinants of preference heterogeneity within our samples, we also estimated LC models for both the New Orleans and U.S. samples. While these efforts were

Table 7. Latent Class Model: U.S. Sample

	Group 1	Group 2
Status quo	1.441**	−0.0736
	(0.623)	(0.1541)
Category 5	3.799***	1.014***
	(1.176)	(0.111)
Coastal restoration	−0.220	0.421***
	(0.873)	(0.138)
Modern transportation	0.990**	−0.184**
	(0.461)	(0.075)
Tax	−0.0088***	−0.002***
	(0.0022)	(0.0004)
Class probability parameters		
Constant	4.881***	0
	(1.176)	
Coastal wetland	−32.558***	0
Importance	(3.266)	
Income	−0.057***	0
	(0.0166)	
Individuals	217	
Observations	868	
Null ln likelihood	−598.8808	
ln likelihood	−479.6496	
Rho-square	0.199	
Iterations	78	

Standard errors are in parentheses.
*** Statistical significance for 1% chance of type I error.
** Statistical significance at 5%.
* Statistical significance at 10%.

inconclusive for the New Orleans sample, the approach did reveal potential sources of variation in preferences among U.S. residents. We focus on a similar specification for the LC model, with a status quo alternative specific constant, a project tax variable, and indicator variables for Category 5 levees, coastal restoration, and modernized transportation systems. Socio-demographic variables defining the finite mixture probabilities are comprised of household income and the Likert-scale response indicating the importance of coastal wetland restoration. Table 7 presents the results of the latent class model for the U.S. sample.[9]

For the U.S. LC model, respondents are endogenously divided into $K = 2$ groups, with posterior probabilities suggesting that roughly 35% of the sample falls into the first group and the remaining 65% in the second group. The class membership probability parameters indicate that the first group views coastal wetland restoration as less important than the second group. The negative sign on the income variable indicates that the first group is represented by lower income households.

The status quo variable is positive and statistically significant for the first group but insignificant for the second group. For each group, the coefficient for Category 5 levees is positive and statistically significant at the 1% level, implying that individuals in both groups prefer projects that employ the maximum level of storm protection. Individuals in the second

[9] Results for the combined model are very similar.

Table 8. Welfare Measures (MWTP)

	Repeated Mixed Logit Models			Latent Class Models		
				U.S. Sample ($)	U.S. Sample ($)	U.S. Sample ($)
	Combined Sample ($)	U.S. Sample ($)	NOLA Sample ($)	Group 1	Group 2	Aggregate
Category 5	**448.75**	**509.16**	**300.87**	**432.56**	**514.39**	**485.75**
95% confidence interval	(263.16, 634.34)	(329.53, 688.79)	(138.54, 463.20)	(269.12, 596.00)	(291.69, 737.09)	(330.43, 641.07)
90% confidence interval	(292.98, 604.52)	(358.40, 659.92)	(164.63, 437.11)	(295.38, 596.74)	(327.49, 701.29)	(355.40, 616.11)
Coastal restoration	**102.88**	86.43	112.86	−25.05	**213.59**	130.06
95% confidence interval	(18.69, 187.16)	(−30.31, 203.17)	(−28.26, 253.98)	(−266.99, 216.89)	(0.78, 426.47)	(−32.20, 292.32)
90% confidence interval	(32.15, 173.62)	(−11.55, 184.41)	(−5.58, 231.30)	(−228.11, 178.01)	(34.93, 392.25)	(−6.13, 266.25)
Modernized transportation	**103.24**	81.42	**137.23**	112.77	**−93.45**	−21.27
95% confidence interval	(−16.36, 222.84)	(−26.83, 189.67)	(−4.22, 278.68)	(−52.91, 278.45)	(−181.57, −5.33)	(−103.29, 60.75)
90% confidence interval	(2.86, 203.62)	(−9.43, 172.27)	(18.51, 255.95)	(−26.28, 251.82)	(−167.41, −19.49)	(−90.11, 47.57)

Statistically significant MWTP estimates in bold.

group respond positively to projects that include coastal restoration, while choices in the first group were not affected by coastal restoration. The coefficient for modern transportation was positive for the first group, but *negative* for the second group (in both cases statistically significant)! Lastly, the coefficient on tax is negative and statistically significant at the 1% level for each group, as expected. The negative impact of cost, however, is four times larger for those in the first group. This pattern of results suggest consistency in the data and internal validity of the LC model, since individuals with less concern over coastal restoration and lower income are more likely to vote against improvements in the rebuilding plan for New Orleans, less likely to support coastal restoration initiatives, and more sensitive to the magnitude of the tax increase.

Table 8 presents MWTP estimates for rebuilding attributes that mitigate future risks to New Orleans and its citizens. Figures 1–3 depict the confidence intervals of MWTP for rebuilding attributes in the different samples. Our estimates indicate that the average individual in the New Orleans sample is willing to pay $301 for Category 5 levee protection versus $509 for the average individual in the U.S. sample. The average individual in the combined sample is willing to pay $449 for Category 5 levees. The confidence intervals, estimated with the Krinsky-Robb procedure, indicate that all welfare estimates for Category 5 levee protection are statistically significant at the 1% level. The latent class model allows us to examine welfare estimates for discrete groups of U.S. residents. The first group, identified as likely to include lower income individuals who view coastal restoration as less important in the rebuilding plan, is associated with a WTP of $433 for Category 5 levees. An average individual from the second group (counterpart to the first group) is willing to pay $514 for Category 5 levees. The difference between these two welfare estimates for the LC model is not statistically significant. The LC MWTP measure aggregated across the two groups is $485. As indicated in Figure 1, all estimates (except New Orleans) exhibit significant overlap and similar central tendencies.

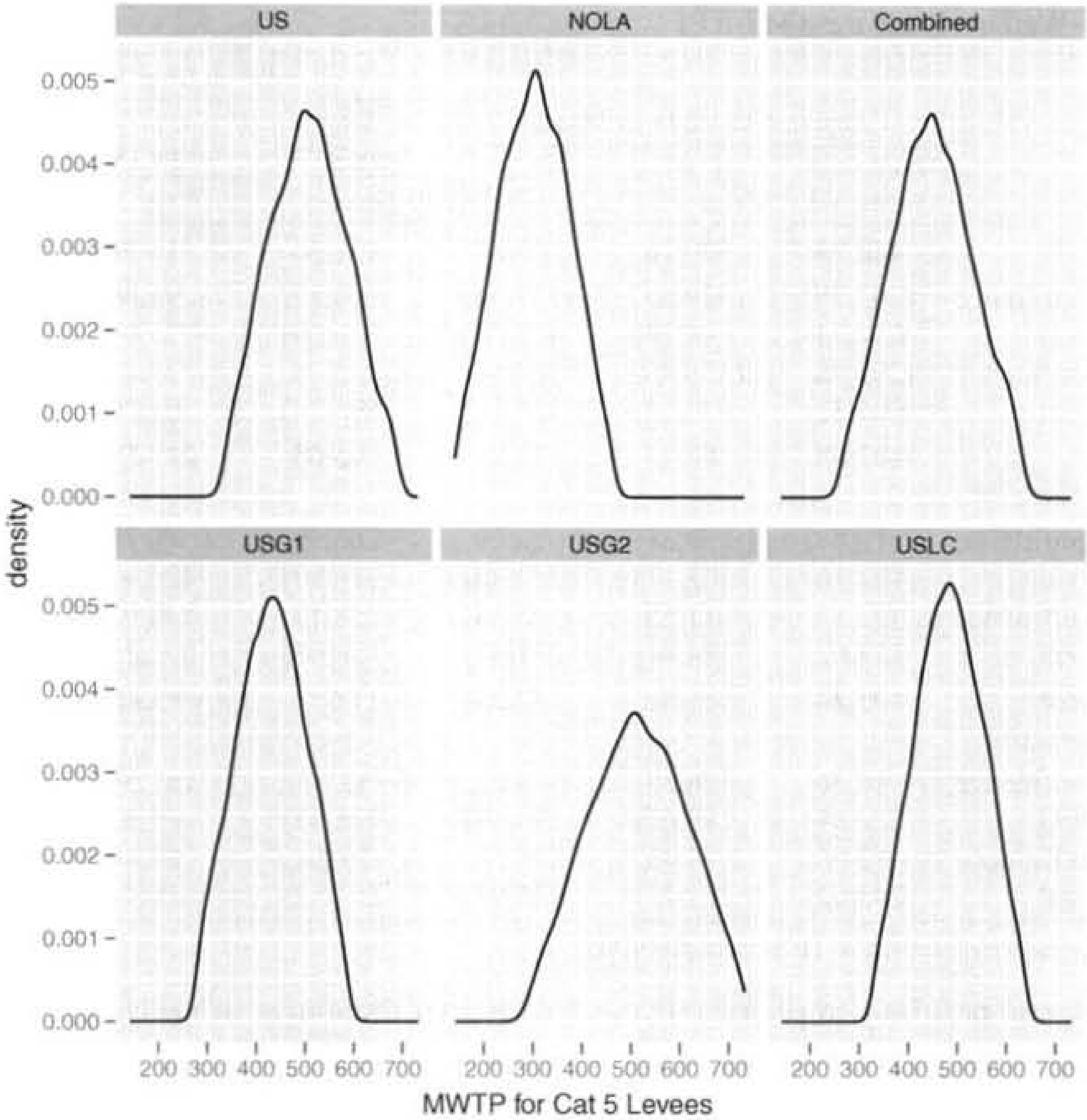

Figure 1. Ninety-five percent confidence intervals depicting MWTP for Category 5 levee protection. Density curves represent United States without New Orleans MSA (US), New Orleans MSA (NOLA), New Orleans MSA and United States (combined), latent class group one of U.S. sample (USG1), latent class group two of U.S. sample (USG2), and aggregated latent class groups (USLC).

Turning to coastal restoration values, we do not obtain statistically significant measures of MWTP for the New Orleans and U.S. samples for the RXL model. In the former case, this result likely reflects the low level of significance for the fixed coastal restoration parameter, while in the latter it reflects wide variability in this random parameter. The average individual in the combined model is willing to pay $103 for coastal restoration, and this estimate is significant at the 5% level. Estimates from the LC model indicate an average individual from the second group in the U.S. sample is willing to pay $214 for coastal restoration. Figure 2 indicates that only the estimates associated with the combined RXL model and group two for the LC model have distributions with sufficient mass above zero.

Lastly, we find that the average individual in the New Orleans sample is willing to pay $137 for modernized transportation (significant at the 10% level), while MWTP for the U.S. sample is not statistically significant in the RXL results. Households in the combined sample are willing to pay $103 for modernized transportation (significant at the 10% level). With the LC model, MWTP for modernized transportation is positive but insignificant for group one, but *negative* and statistically significant for group two! The average person in group two—more likely to include higher income households and individuals that view coastal restoration as

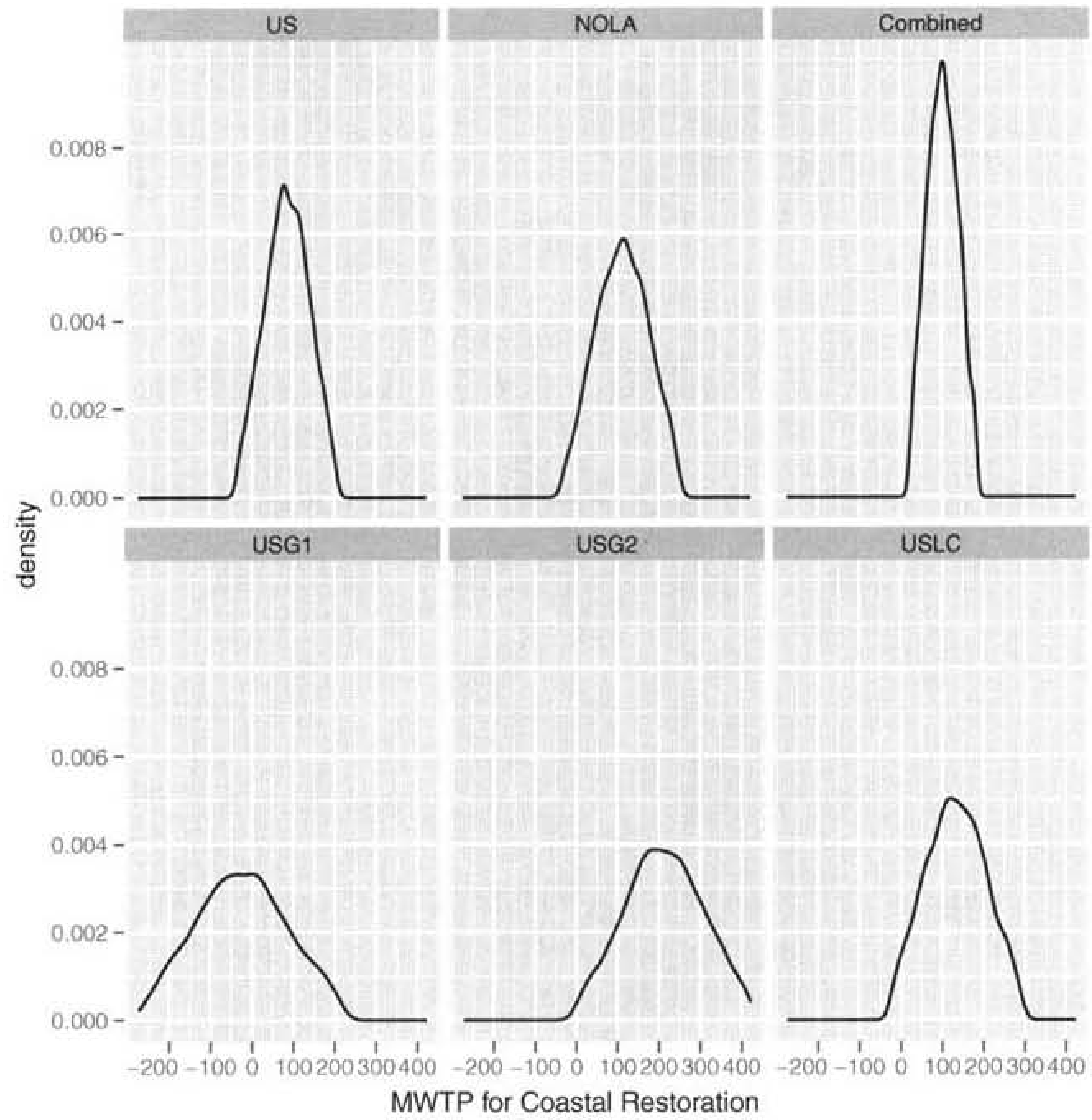

Figure 2. Ninety-five percent confidence intervals depicting MWTP for coastal restoration. Density curves represent United States without New Orleans MSA (US), New Orleans MSA (NOLA), New Orleans MSA and United States (combined), latent class group one of U.S. sample (USG1), latent class group two of U.S. sample (USG2), and aggregated latent class groups (USLC).

important—has a negative MWTP of −$93.45 (significant at the 5% level), implying that they view modernized transportation as an economic "bad." The point estimate for aggregate MWTP for the LC model is negative but not significantly different from zero. These distributions of MWTP are depicted in Figure 3.

7. Discussion and Conclusions

Employing choice experiments via a random digit dialing telephone survey, we produce estimates of economic value for public projects that reduce risk from severe storms. Our experiment offers improvements in levee flood protection, coastal restoration, and improvements in transportation infrastructure. Each alternative improvement scenario is associated with higher one-time payment of federal taxes for all U.S. households. These improvements are valued in pairwise comparisons with status quo conditions, and thus our estimates represent MWTP for risk-reducing projects. Each subject evaluates four pairwise choice sets of the total 16 choice sets, which were designed using efficient algorithms for linear models. The choice

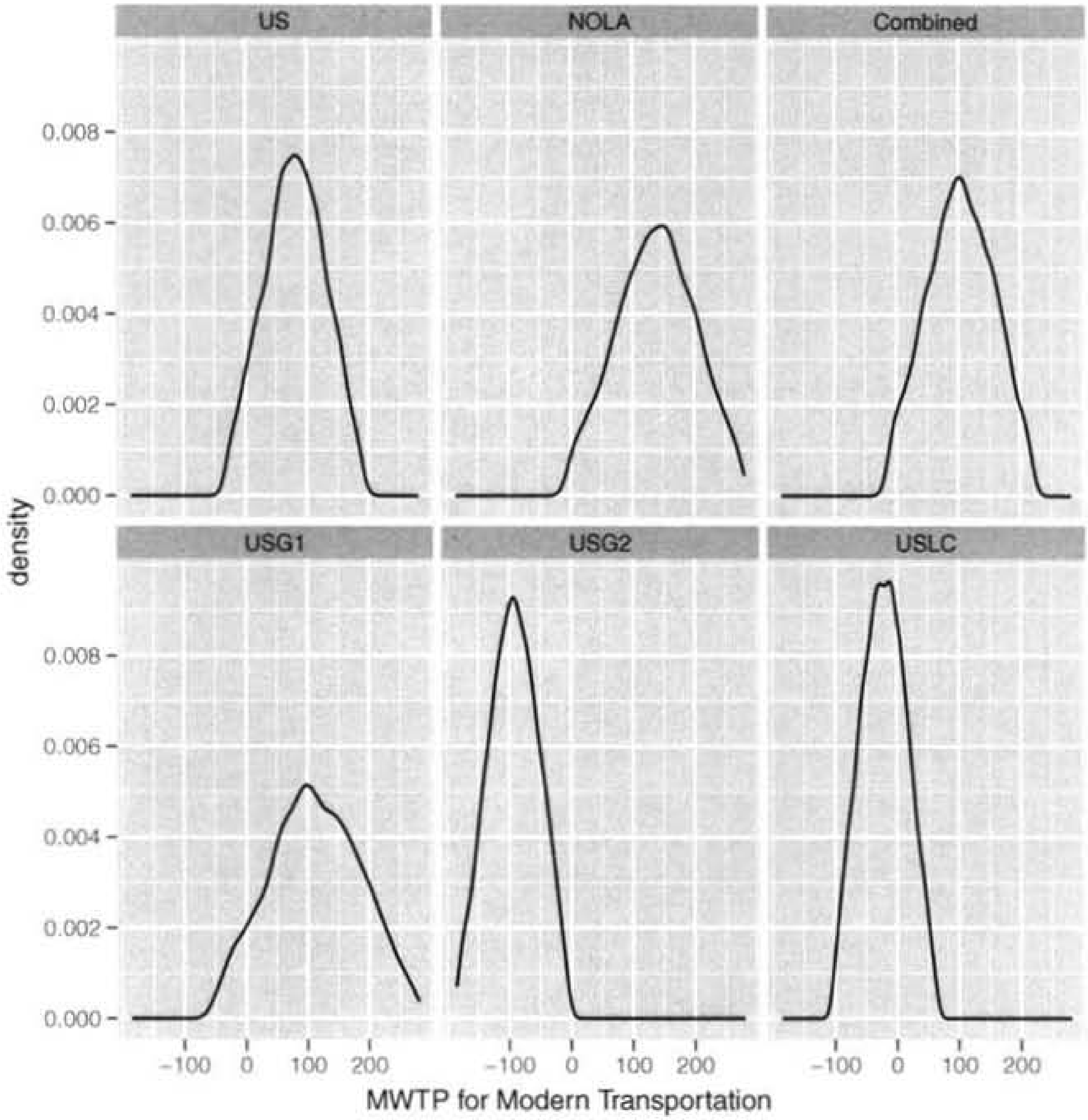

Figure 3. Ninety-five percent confidence intervals depicting MWTP for modern transportation. Density curves represent United States without New Orleans MSA (US), New Orleans MSA (NOLA), New Orleans MSA and United States (combined), latent class group one of U.S. sample (USG1), latent class group two of U.S. sample (USG2), and aggregated latent class groups (USLC).

experiment was implemented as a referendum with majority rules provision, and subjects were instructed to treat each choice as independent of other choices.

In general, respondents find traditional engineered flood protection structures to be the most valued line of defense. The local and national sentiment indicates that bolstering levees to withstand a Category 5 storm represents a valuable public investment. One explanation for the high valuation of Category 5 levee protection is that it may be viewed as certain protection, since 5 is the highest rating on the Saffir-Simpson scale. Experimental evidence from Wakker, Thaler, and Tversky (1997) demonstrates that people require a disproportionally high discount in order to accept probabilistic insurance (insurance that does not pay with 100% certainty). This is seen as an effect of decision weighting in prospect theory. Coastal restoration garners some support but not to the degree that engineered flood protection systems received. Lastly, improved transportation systems are supported but not as strongly as levee improvement and coastal restoration.

Results of the repeated mixed logit model indicate that households in the New Orleans metropolitan area are willing to pay \$301 per household for Category 5 levee protection and \$137 per household to modernize the New Orleans metropolitan transportation system. In addition to households' values for Category 5 levee protection, which primarily reflects a form of hazard mitigation, benefits from modernized transportation also represent an improvement to quality of life via better day-to-day transportation options. Estimates of value for coastal restoration for New Orleans residents are not statistically significant. Aggregating over all New Orleans tax-paying households, estimated economic value for Category 5 flood protection is approximately $118 million (95% confidence interval: $54–181 million).[10] The aggregate economic value of modernized transportation infrastructure for tax-paying New Orleans households is $54 million (90% confidence interval: $7–100 million).

We also present results for a sample of U.S. households that were offered the opportunity to vote in the same choice experiment. Surprisingly, U.S. residents are willing to pay $509 per household for Category 5 levees in New Orleans. This mean estimated economic value exceeds New Orleans residents' mean MWTP by 69%. Comparing opinions on flood protection, 84% of U.S. respondents feel it is "very important" to protect New Orleans from floods, compared to 98% of New Orleans residents. Thus, this economic value could indicate a true preference for flood protection in this vulnerable and culturally distinct location. The difference could reflect a higher income for the U.S. population relative to New Orleans residents, assuming flood protection is a normal good.

Accounting for preference heterogeneity via the repeated mixed logit model, we do not find a statistically significant economic value for U.S. households that can be attributed to coastal restoration in South Louisiana. Further investigation, however, using the latent class model allows us to endogenously divide the U.S. sample into two distinct groups based on observable factors. The first group is more likely to include lower income households that do not view coastal wetland restoration as important, while the second group is characterized by those with higher incomes and who place greater importance on coastal restoration. WTP for coastal restoration for the first group is not significantly different from zero, but the average individual in the second group is willing to pay $214 for coastal restoration. Members of the first group may be less familiar with coastal wetlands, in general, and unaware of the storm protection provided by coastal marshes. Fifty-two percent of U.S. respondents consider coastal restoration as "very important," considerably less than the 86% of New Orleans residents that express this view. Using posterior probabilities, we estimate that the average likelihood of individuals in our sample belonging to the first group is around 35%.

Lastly, with the repeated mixed logit model, U.S. respondents' WTP for improvements in transportation infrastructure is not statistically significant; again, the LC model reveals different results. While we did not find a significant result for the first group, parameters for the second U.S. group exhibited a *negative* and statistically significant WTP for modernized transportation. This result may indicate that these types of individuals disapprove of development in high risk areas and do not want to create an incentive for expanded redevelopment in the form of modernized transportation. Public services, such as utilities and public transportation, act as de facto land use policy since they provide access to more locations. This, in effect, can create incentives for development because a larger proportion of the population can access more remote areas. Without modern transportation, people may be dissuaded from developing in remote or high risk locations.

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[10] According to the 2005–2007 American Community Survey 3-Year Estimates, there are 392,659 households in the New Orleans MSA.

Combining the two samples and reweighting for representation at the national level and to correct for response bias based on observable factors, we produce tentative estimates of economic value for risk-reduction in New Orleans. Under the assumption that this sample is a reasonable approximation of national preferences, the average U.S. household is willing to pay $449 for upgrading New Orleans's levee system to withstand a Category 5 storm, and the average WTP for coastal restoration is $103 per household. The average U.S. household is WTP $103 for modernized transportation in New Orleans. Aggregating over all U.S. tax-paying households, economic values for rebuilding New Orleans are approximately $50 billion (95% confidence interval: $29–71 billion) for Category 5 flood protection in New Orleans, $12 billion (95% confidence interval: $2–21 billion) for coastal restoration, and $12 billion (90% confidence interval: $0.3–21 billion) for modernized transportation.[11]

Although a comprehensive cost–benefit analysis is beyond the scope of this study, these estimates could provide valuable information for policymakers as they analyze risk-reducing projects for post-Katrina New Orleans and southern Louisiana. While there are no definitive or inclusive estimates of costs to rebuild New Orleans, Congressional reports suggest that the total cost of various rebuilding projects could be close to $200 billion.[12] Such high cost estimates raise important questions as to whether rebuilding New Orleans makes economic sense. To date, the federal government has provided billions of dollars in assistance to the Gulf Coast to repair and rebuild damaged public infrastructure. An article in the *Washington Post* reports that the cost of rebuilding New Orleans's levees has been about $10 billion, although the cost may increase to fully protect the entire region ("Levee Repair Costs Triple" March 31, 2006). The cost to protect and restore coastal wetland in Louisiana has been estimated at $14 billion over a 30-year period (National Research Council of the National Academies 2006).[13] While details remain to be settled, our benefit estimates suggest that at least selective rebuilding on the basic infrastructure could be justified from an economic efficiency perspective. Hopefully, this study will stimulate future research on the costs and benefits of rebuilding New Orleans as more carefully constructed estimates become available.

Appendix A: Choice Experiment

Remember, the current plan is (i) limited bus service, street cars, and conventional roads; (ii) no restoration of coastal wetlands; (iii) repair the levees to withstand a Category 3 hurricane; and (iv) no additional taxes.

1. *Transportation and the levees would be the same as the current plan. This alternative plan proposes to restore coastal wetlands. This plan would cost each U.S. household an extra $300. Would you vote for the current plan or this new plan?*
2. *The levees and the coastal wetlands would be the same as the current plan, but the new plan would include improvements in the transportation system. This plan would cost each U.S. household an extra $450. Would you vote for the current plan or this new plan?*
3. *The transportation and the coastal wetland restoration would be the same as the current plan, but the new plan would include improvements in the levees to protect the city against a Category 5 hurricane. This plan would cost each U.S. household an extra $50. Would you vote for the current plan or this new plan?*

[11] According to the 2005–2007 American Community Survey 3-Year Estimates, there are 111,609,629 households in the United States.

[12] The Congressional Budget Office estimated the value of capital stock destroyed by Hurricanes Katrina and Rita in the range of $70–130 billion, and the State of Louisiana estimated that the cost to the state alone could reach $200 billion (U.S. GAO 2007).

[13] The extent of the damage caused by Hurricanes Katrina and Rita was not fully determined at the time of this report. The report also provides that the use-value of wetlands estimated by the State of Louisiana is in excess of $37 billion by 2050.

4. *In this plan, the transportation system would be improved, the coastal wetlands restored, and the levees improved to protect the city against a Category 5 hurricane. This plan would cost each U.S. household an extra $150. Would you vote for the current plan or this new plan?*

Example of Conjoint Choice Set Alternatives for Block 1.

Set	Transportation	Coastal Restoration	Levee	Tax
1	Conventional	Yes	Category 3	$300
2	Modern	No	Category 3	$450
3	Conventional	No	Category 5	$50
4	Modern	Yes	Category 5	$150

Appendix B: Cheap Talk Script

We would now like to ask you about four rebuilding plans for New Orleans. The plans differ in the types of improvements that are made to the city and the cost to tax-payers. Suppose that each of the plans are put up for a vote, you may vote for or against each plan or choose not to vote—majority rules.

Before we get to the vote, consider the following information. In a recent study, groups of people participated in a vote just like the one you are about to participate in. The improvements and costs of the plan for these groups were not real, just as they will not be real for you. No one had to pay money if the vote passed, and most voted *for* the plan.

Other groups of similar people participated in the *same* vote, but payment was *real* and everyone *really did have to pay the cost* if the vote passed. In these groups most voted *against* the plan. We call this difference between the way people say they would vote and the way they really vote *"bias."*

Sometimes when we hear about a vote that involves doing something that is basically good—helping people in need, improving air and water quality, or anything else—our reaction in a hypothetical situation is to think: *sure*, I would do this. I *really would* vote to spend the money.

But when the vote is real, and we would actually have to spend our money if it passes, we think a different way. We still would like to see good things happen, but when we are faced with having to spend money, *we think about our options*; if I spend money on this, that's money I don't have to spend on other things. We vote in a way that takes into account the limited amount of money we have.

I would like for you to think about your votes just like you would think about a real vote, where if enough people vote for the plan, you'd really have to pay and so would everyone else. Please keep this in mind as you answer the four voting questions.

For the purpose of these questions, the *current* rebuilding plan for New Orleans will be

- Limited bus service (routes, transfer points, and hours of service buses), limited use of street cars, and conventional road network
- No restoration program for Louisiana's coastal wetlands
- Repair the levee system to withstand a Category 3 hurricane
- You pay $0 in additional tax money for one year

We will now give you the opportunity to vote on four separate plans for rebuilding. Each of the four plans differs in the type of improvements that are made and the associated costs. Money to fund the plan would come from a *one-time tax* on all U.S. households. The tax amount differs due to the nature of the rebuilding plan and because we are uncertain about what the actual costs would be. Assume that all money raised would go *directly* to rebuilding New Orleans.

Please consider each plan separately in relation to the current plan and indicate whether or not you would vote for this plan if the vote were *real*.

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