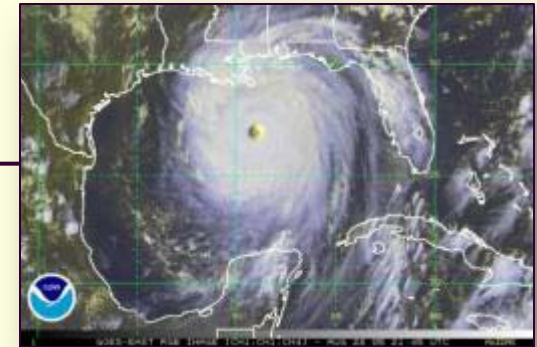# Determinants of Household Hurricane Evacuation Choice in Florida

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Introduction

- Hurricanes are the most costly natural disasters in the U.S. and they are especially harmful to coastal areas (NSC, 2007).

- The main goal of an evacuation is to reduce the risk of injury or death.

- However, evacuation behavior depends not only on information regarding the hurricane characteristics but also upon household socioeconomic and demographic characteristics.

Introduction

- Thus, studying the determinants of household evacuation can help to target public resources more efficiently by focusing on those individuals with higher risk and on those with lower probabilities to evacuate.

- Previous studies have been conducted, using data for a single event within very specific geographical areas.

- By doing so, they miss a time and space component and overlook the possibility that households may learn from their own experience.

- This study constitutes a natural extension of previous studies by comparing two distinct regions and four separate hurricane events during the 2005 season.

Conceptual Framework

- Burton (1993) & Viscusi (1995) present the theoretical basis to analyze human behavior under environmental risk.

- Individuals make choices under the uncertainty of future environmental threat by maximizing their expected utilities, and that they might be willing to sacrifice their wealth in order to reduce those threats.

- Individual's response is affected by four major elements:
  - Prior experience with the specific environmental hazard;
  - Individual's wealth;
  - Intrinsic characteristics; and
  - Interaction with society.

Empirical Model

Based on the theory and previous studies we estimated the following evacuation model using a **Probit** procedure:

$$E_i = f(R_i, W_i, I_i, S_i, O_i)$$

E: Evacuation choice

R: Individual's perception of risk and their previous hurricane experience;

W: Wealth and/or income;

I: Household demographics;

S: Social interaction and sources of information; and

O: Other variables.

Table 1. Variable Definition.

Variable	Definition
Dependent variable	
EVACUATION	*Dummy* variable equal 1 if the household evacuated their house during the studied storm, 0 otherwise.
Prior experience and risk perception	
EXPERIENCE	*Dummy* variable equal 1 if the household has had previous experience with hurricanes, 0 otherwise.
MOBILE	*Dummy* variable equal 1 if the household lives in a mobile home, 0 otherwise.
FLOOD	*Dummy* variable equal 1 if the household lives in an area with flood risk, 0 otherwise.
Wealth	
INCOME	Combined household income (US $).
OWN	*Dummy* variable equal 1 if the household owns their house, 0 otherwise.
Household characteristics	
FAMSIZE	Number of people living in the household.
KIDS	Number of kids in the household (less than 18 yeas of age).
PETS	*Dummy* variable equal 1 if the household owns a pet, 0 otherwise.
Interaction with society	
FRIENDS	*Dummy* variable equal 1 if the decision to evacuate was influenced by friends
NOAA	*Dummy* variable equal 1 if the household uses the NOAA radio, 0 otherwise.
Others	
EXPENSES	Total cost (US $) for the household evacuation preparation plan
SFL	*Dummy* variable equal 1 if the household is located in South East Florida, 0 otherwise.

Data

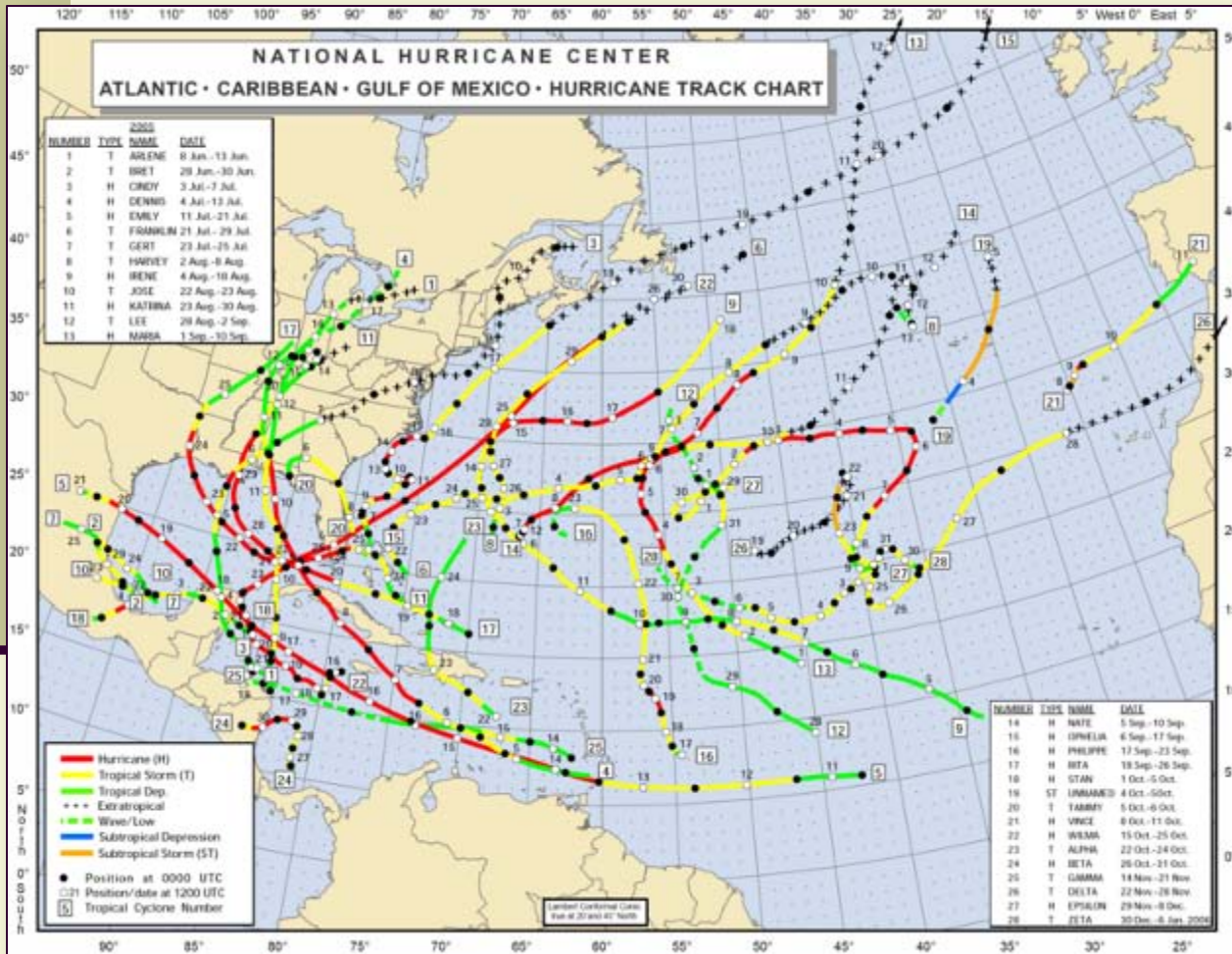- The data was gathered using a web-based survey

- A subsample was selected to include:
  - households living in the study areas (NW and SE FL) during the 2005 hurricane season;
  - who experienced Katrina, Wilma or Dennis; and
  - answered variables key to our analysis.

- The final dataset encompasses a total of 1,355 households.

2005 Atlantic Season

The 2005 Atlantic hurricane season was the most active and harmful in recorded history (NHC, 2006) :

➢ 2,300 deaths
➢ $130 billion in damages

Number of Tropical and Subtropical Storms	28
Number of Hurricanes	15
Number of Major Hurricanes (Cat. 3-5)	7

Dennis

June 10, CAT 2

Wilma

October 23, CAT 2

Katrina

August 29, CAT 3

August 25, CAT 1
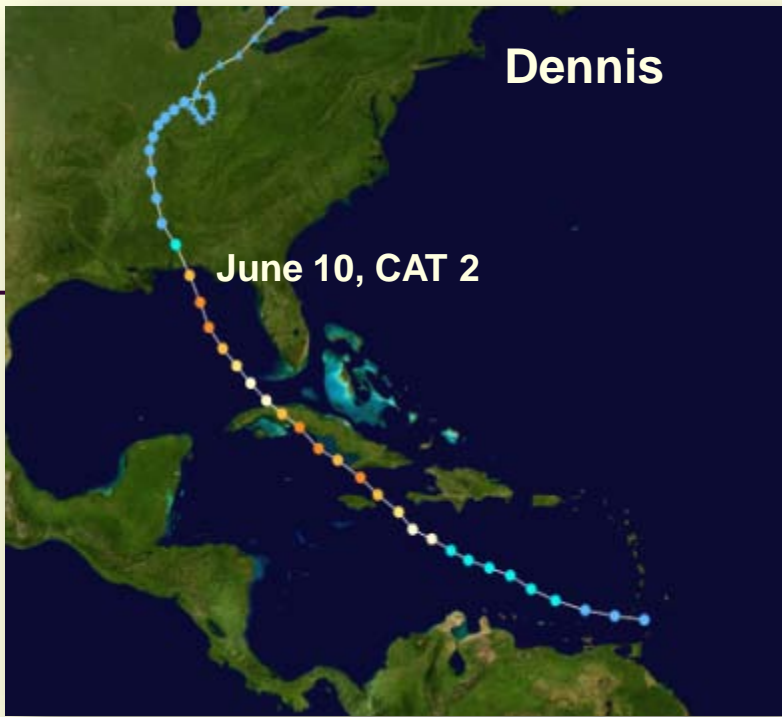
2005 Season in Florida

3 Hurricane
4 Events (2 SE FL, 2NW FL)

Results and Discussion

Table 4. Probit estimates of evacuation decision.

Variable	ALL Coef.	ALL ME	KATRINA SE Coef.	KATRINA SE ME	WILMA Coef.	WILMA ME	DENNIS Coef.	DENNIS ME	KATRINA NW Coef.	KATRINA NW ME
CONSTANT	0.168	--	-0.259	--	-0.411*	--	-0.189	--	-0.231	--
	0.133		0.262		0.230		0.356		0.474	
EXPERIENCE	0.141*	0.059	0.409*	0.161	0.205*	0.083	0.108	0.039	0.060	0.021
	0.071		0.228		0.123		0.151		0.129	
MOBILE	0.881**	0.333	1.098***	0.420	1.031***	0.438	0.751***	0.322	0.701**	0.291
	0.125		0.347		0.268		0.214		0.291	
FLOOD	0.226***	0.099	0.557***	0.187	0.237*	0.086	0.082	0.031	0.073***	0.028
	0.085		0.178		0.136		0.223		0.019	
INCOME	0.019	0.005	-0.013	-0.005	0.057	0.020	0.025	0.009	0.057	0.021
	0.011		0.057		0.050		0.076		0.100	
OWN	-0.231***	-0.106	-0.473**	-0.175	-0.482**	-0.177	-0.093*	-0.034	-0.279*	-0.102
	0.079		0.177		0.225		0.053		0.143	
FAMSIZE	-0.026	-0.011	-0.099	-0.036	-0.067	-0.023	0.013	0.005	-0.014	-0.005
	0.047		0.080		0.076		0.094		0.119	
CHILDREN	0.103*	0.050	0.187*	0.069	0.165*	0.059	0.121***	0.047	0.144***	0.053
	0.057		0.113		0.096		0.017		0.021	
PET	-0.206**	-0.078	-0.487**	-0.166	-0.354**	-0.119	-0.260*	-0.101	-0.228**	0.091
	0.096		0.193		0.161		0.146		0.108	
FRIENDS	0.062	0.028	0.086	0.032	0.111	0.040	0.041	0.015	0.105	0.040
	0.081		0.157		0.132		0.171		0.213	
NOAA	-0.039	-0.017	-0.130	-0.047	-0.046	-0.016	0.120	0.046	-0.046	-0.018
	0.078		0.173		0.149		0.122		0.213	
EXPENSES	-0.047**	-0.020	-0.091*	-0.034	-0.032	-0.012	-0.097**	-0.039	-0.073**	-0.028
	0.025		0.052		0.1349		0.045		0.031	
MAJOR	0.574***	0.221	--		--		--		--	
	0.069									
SFL	0.423**	0.199	--		--		--		--	
	0.170									
Log likelihood		-906.35		-369.73		-235.10		-327.03		-218.22
McFadden Pseudo R²		0.37		0.33		0.31		0.32		0.34
Model χ² [df]		171.62 [13]		124.48 [11]		153.25 [11]		126.62 [11]		119.58 [11]
% of Correct		74.15		62.48		61.61		67.23		69.15

- The estimated models perform fairly well and the estimates are consistent across storms.
- The H_0 that all coeff. are simultaneously 0 is rejected consistently at the 1%
- Approximately 55.6% of all parameters are statistically different from 0 and their signs are generally consistent with expectations
- In addition, the % of correctly predicted responses are high

Risk Perception

- On averages, households living in ***mobile homes*** are 36.3% more likely to evacuate than their counterparts.
    - **MOBILE** display the highest ME in all models.
    - Baker (1991) indicates that emergency managers tend to target mobile home residents in their evacuation procedures.
- Households in ***flooding areas*** display, on average, an 8.6% higher probability to evacuate than those living in non-flooding zones.
- In addition, those households that have ***experienced*** the treat of a major hurricane in the past also display higher probabilities to evacuate.
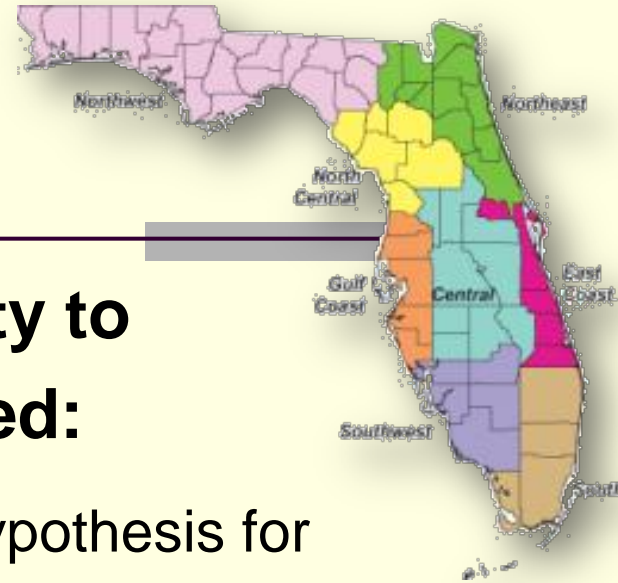
Household Wealth

- ***Home ownership*** reduces the probability of evacuation in all estimated models.
  - Homeowners in SE FL show lower probabilities to evacuate than homeowners in NW FL.
- ***INCOME*** is not statistically different from 0.
  - Mixed results have been previously reported in the literature:
  - Whitehead (2000) ⟹ **+**
  - Whitehead (2003) ⟹ **−**
  - Smith (1999) ⟹ **not significant**

All among coastal residents in North Carolina

Household Composition

- The ***number of children*** is significant and (**+**)
  - One additional child in the household increases the probability to evacuate on approximately 5%.
- ***Family size*** is (**-**) but not significantly.
- Households with ***pets*** have also lower rates of evacuation.
  - Owning a pet decreases the average probability to evacuate in 11.2%.
  - Whitehead (2000) suggested that establishing pet-friendly shelters could significantly increase the evacuation rates.

Household Evacuation Preparation

■ The total cost for the household evacuation preparation plan is (-) and significant.

    ■ On average, an extra dollar expended in the evacuation preparation plan decreases the probability of evacuation in a 3%.

    ■ Households might consider storm preparation as a risk mitigation measure and feel more secure remaining behind with their home.

Location

- **Regional differences in propensity to evacuate are clearly demonstrated:**

  - A likelihood ratio test rejects the null hypothesis for equality across geographical regions.

  - This variation is confirmed by the statistically significance of the variable SFL in model ALL.

  - The ME for SFL suggest that households living in SE FL are, approximately, 20% less like to evacuate than people living in NW FL,

  - This results agree with the idea that evacuation policies cannot be global and they should be developed based on the specific characteristic of the population (Fu, 2004)

Time

- We used Chow-type test (Greene, 2002) to analyze whether there is a significant difference in behavior among households living in the same area.
  - Households in NW FL behaved in the same way for the two studied storms (**no time effect**).
  - Households in SE FL did change their behavior through time (**+ time effect**).
- These results agree with the pattern found for the variable **EXPERINCE**.
  - **EXPERINCE** was significant for households in SE FL,
  - **EXPERINCE** was non-significance for NE FL residents.

Concluding Remarks

- The results suggest that households living in ***risky environments***, with ***children***, and with previous ***hurricane experience*** are more likely to evacuate.

- In contrast, ***homeowners*** and households with ***pets*** are less likely to evacuate.

- The more people ***spend on storm preparation*** the less likely they are to evacuate. Households might consider storm preparation as a risk mitigation measure.

- ***Regional and time*** differences are clearly demonstrated.