Distributional Impacts of Public Flood Insurance Reform

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Appendix

A Data Sources and Construction

We begin with all arms-length sales for owner-occupied residential properties from the Miami-Dade, Port St. Lucie, Fort Lauderdale Combined Statistical Area (CSA) from 2009 to 2012. The data are provided by Dataquick, Inc., and include information on selling price, date of sale, numbers of bedrooms and bathrooms, and mortgage information. Structural characteristics are available as recorded from county assessor offices; those that we use for flood premium calculation are: exact latitude and longitude location, year built, house type (i.e. single family, mobile, condominium), and mortgage loan value (in thousands). To characterize the neighborhoods in which houses are located, we use GIS shapefiles obtained from the Yale University Map Department to map each house to nearby spatial amenities, including the distances to the nearest park, river, and coast. To control for local environmental quality, we join each house with levels of industrial contaminants, as operationalized by the count of sites within 3 kilometers of the property, in the year of property sale, that are listed on Florida's Institutional Controls Registry (ICR). ICR data are available from the Florida Department of Environmental Protection. Public school quality has also been documented as an important amenity over which people sort (Black, 1999; Epple and Sieg, 1999; Bayer et al., 2007), so we include Florida Comprehensive Assessment Test (FCAT) scores for each school district, in each year, from the Florida Department of Education to proxy for school quality. The FCAT performance score evaluates achievement in the categories of reading, mathematics, science, and writing, out of a combined maximum of 400 possible points. Finally, as prospective buyers may have preferences over their future neighbors, we collect tract-level per-capita income and race/ethnicity population shares. As these neighborhood demographics are endogenously determined based on residents' locational choices, we use predetermined neighborhood demographics from the 1990 census, which are mapped to 2010 census tracts using the Longitudinal Tract Data Base (Logan et al., 2014).

Digitized Flood Insurance Rate Maps (FIRMs), accessed from FEMA's Map Services Center and the Florida Geographic Data Library, are used to assign the underlying flood risk level to each house (in all zones) based on the FIRM that was in effect as of the property's sale date. We first map all houses to their flood zone (including a Base Flood Elevation (BFE),

Figure A.1: NFIP Premium Rate Example

ANNUAL RATES PER $100 OF COVERAGE (Basic/Additional)

FIRM ZONES A, AE, A1–A30, AO, AH, D[3]

	OCCUPANCY	SINGLE FAMILY		2-4 FAMILY		OTHER RESIDENTIAL		NON-RESIDENTIAL BUSINESS[4]		OTHER NON-RESIDENTIAL[4]	
		Building	Contents	Building	Contents	Building	Contents	Building	Contents	Building	Contents
BUILDING TYPE	No Basement/Enclosure	1.21 / 1.11	1.52 / 1.99	1.21 / 1.11		1.21 / 2.34		1.32 / 2.46		1.32 / 2.46	
BUILDING TYPE	With Basement	1.29 / 1.64	1.52 / 1.67	1.29 / 1.64		1.21 / 1.95		1.39 / 2.40		1.39 / 2.40	
BUILDING TYPE	With Enclosure[5]	1.29 / 1.96	1.52 / 1.99	1.29 / 1.96		1.29 / 2.44		1.39 / 3.04		1.39 / 3.04	
BUILDING TYPE	Elevated on Crawlspace	1.21 / 1.11	1.52 / 1.99	1.21 / 1.11		1.21 / 2.34		1.32 / 2.46		1.32 / 2.46	
BUILDING TYPE	Non-Elevated with Subgrade Crawlspace	1.21 / 1.11	1.52 / 1.67	1.21 / 1.11		1.21 / 2.34		1.32 / 2.46		1.32 / 2.46	
BUILDING TYPE	Manufactured (Mobile) Home[6]	1.21 / 1.11	1.52 / 1.99					1.32 / 2.46		1.32 / 2.46	
CONTENTS LOCATION	Basement & Above[7]				1.52 / 1.67		1.52 / 1.67		2.59 / 4.12		2.59 / 4.12
CONTENTS LOCATION	Enclosure & Above[8]				1.52 / 1.99		1.52 / 1.99		2.59 / 4.93		2.59 / 4.93
CONTENTS LOCATION	Lowest Floor Only – Above Ground Level				1.52 / 1.99		1.52 / 1.99		2.59 / 2.16		2.59 / 2.16
CONTENTS LOCATION	Lowest Floor Above Ground Level and Higher Floors				1.52 / 1.39		1.52 / 1.39		2.59 / 1.85		2.59 / 1.85
CONTENTS LOCATION	Above Ground Level – More Than 1 Full Floor				.35 / .12		.35 / .12		.24 / .12		.24 / .12
CONTENTS LOCATION	Manufactured (Mobile) Home[6]								2.59 / 2.16		2.59 / 2.16

FIRM ZONES V, VE, V1–V30

	OCCUPANCY	SINGLE FAMILY		2-4 FAMILY		OTHER RESIDENTIAL		NON-RESIDENTIAL BUSINESS[4]		OTHER NON-RESIDENTIAL[4]	
		Building	Contents	Building	Contents	Building	Contents	Building	Contents	Building	Contents
BUILDING TYPE	No Basement/Enclosure	1.57 / 2.79	1.96 / 4.78	1.57 / 2.79		1.57 / 5.16		1.75 / 5.97		1.75 / 5.97	
BUILDING TYPE	With Basement	1.69 / 4.15	1.96 / 4.05	1.69 / 4.15		1.69 / 7.69		1.85 / 8.85		1.85 / 8.85	
BUILDING TYPE	With Enclosure[5]	1.69 / 4.89	1.96 / 4.77	1.69 / 4.89		1.69 / 8.57		1.85 / 9.88		1.85 / 9.88	
BUILDING TYPE	Elevated on Crawlspace	1.57 / 2.79	1.96 / 4.78	1.57 / 2.79		1.57 / 5.16		1.75 / 5.97		1.75 / 5.97	
BUILDING TYPE	Non-Elevated with Subgrade Crawlspace	1.57 / 2.79	1.96 / 4.05	1.57 / 2.79		1.57 / 5.16		1.75 / 5.97		1.75 / 5.97	
BUILDING TYPE	Manufactured (Mobile) Home[6]	1.57 / 8.75	1.96 / 4.77					1.75 / 16.83		1.75 / 16.83	
CONTENTS LOCATION	Basement & Above[7]				1.96 / 4.05		1.96 / 4.05		3.41 / 10.45		3.41 / 10.45
CONTENTS LOCATION	Enclosure & Above[8]				1.96 / 4.77		1.96 / 4.77		3.41 / 11.29		3.41 / 11.29
CONTENTS LOCATION	Lowest Floor Only – Above Ground Level				1.96 / 4.77		1.96 / 4.77		3.41 / 9.46		3.41 / 9.46
CONTENTS LOCATION	Lowest Floor Above Ground Level and Higher Floors				1.96 / 4.19		1.96 / 4.19		3.41 / 8.17		3.41 / 8.17
CONTENTS LOCATION	Above Ground Level – More Than 1 Full Floor				.59 / .51		.59 / .51		.57 / .73		.57 / .73
CONTENTS LOCATION	Manufactured (Mobile) Home[6]								3.41 / 15.73		3.41 / 15.73

if determined in the FIRM),[1] and then combine this information with available structural characteristics from the sales data (e.g. year of sale and single family or 2-4 family house) and the year a house was built. This information is sufficient to determine the effective premium rate that each house should face, based on the NFIP Technical Manual (NFIP, 2016). Figure A.1 presents an example of an NFIP rate assignment. Owners in Special Flood Hazard Areas with such lender flood-insurance requirements must purchase an amount of coverage that is the lesser of (1) the outstanding principal balance of the loan, (2) the maximum NFIP coverage limit ($250,000 for residential buildings), or (3) the total insurable value of the property (Flood Smart, 2016). As an example, suppose a single-family dwelling in any of the A zones that was built before the NFIP has a loan of $150k. Assuming the property has no basement, the "basic" premium rate is $1.21 per $100 of building coverage for the first $60k of coverage, and then $1.11 per $100 of coverage using the "additional" rate for building coverage beyond $60k, up to $250k. The annual premium would be calculated as $\$1725 = \$1.21 \times \$600 + \$1.11 \times (\$1500 - \$600)$. If the loan value was $300k, then the coverage required would be capped at $250k, making the calculated annual premium equal to $\$2836 = \$1.21 \times \$600 + \$1.11 \times (\$2500 - \$600)$.

Three structural characteristics, required for assigning the building premium rate, are missing from our housing data. These are (1) for condominiums, the size of the building in

[1] Base Flood Elevation is the computed elevation to which floodwater is anticipated to rise (NFIP, 2016).

which a condominium is located (e.g. high rise versus low rise); (2) whether the property contains a basement or enclosure, and (3) the elevation of the lowest floor. We make a few necessary assumptions in the face of these data limitations, namely that (1) unit owners of condominiums purchase individual policies, rather than being covered through their homeowner's association (HOA), (2) houses have no basements or enclosures, (3) the lowest floor elevation of a building is 0, equal to the ground in elevation (i.e., not raised above or lowered below), and (4) homes have an elevation certificate if required by county ordinance. We provide a few remarks on these necessary assumptions and their implications.

First, by assuming that condominium owners purchase individual flood insurance policies, we consider all condominium units as single family residences, whereas the policy rates for the alternative option, obtaining coverage through the HOA, depends on the number of units in the building (i.e., data we do not have). Policies through an HOA generally provide greater coverage for a lower premium (FEMA, 2013), so our assumption will tend to overstate the flood risk internalized by these households and attenuate our estimated preferences to avoid risk.

Second, unobserved basements could alter the coverage premium greatly, which would also cause us to miscalculate the price discount. In practice, however, basements are not very common in the South Atlantic states. Data from the Census Survey of Construction Microdata Files, which include annual single-family housing starts, completion, and/or sales in the U.S., at the Census Division level, show that approximately 82 percent of new construction in the New England and Mid-Atlantic states between 1999 and 2012 includes basements, compared to only 20 percent for South Atlantic states (as far north as Delaware).[2] The proportion for Florida is even lower, given that this coastal state has predominantly a limestone substrate and a shallow water table, making basement construction costly and difficult. A search of Realtor.com, a real-estate listings website, reveals that only 28 out of 25,186 homes listed for sale in Miami-Dade County in December of 2018 are listed as having a basement. Of the subset of houses in our data with basement information, only 0.04 percent have a basement.

Third, for a subset of homes in the SFHA,[3] the (post-FIRM) premium rate depends on the elevation difference, which is the difference between the elevation of the lowest floor of the building and the base flood elevation that is assigned to the building's FIRM. In our sample, 4.7 percent of houses belong to these zones and are post-FIRM. If houses have actually been raised, then our assumption that the lowest-floor elevation is the same as the surface elevation would cause us to over-estimate the relevant flood-insurance premium. In practice, however, homes elevated high on pylons are not common in South Florida, unlike other areas

[2]Statistics are based on the authors' calculations.

[3]Specifically, the areas are un-numbered A, AE and VE zones.

along the Gulf Coast. In addition, some localities have zoning ordinances specifically limiting people's ability to build above ground elevation. For example, until July 2018, a local height restriction ordinance in Miami Beach forced homes to have their first floor no more than seven feet above ground level (Rabines, 2018).

A final assumption we make is that all houses have elevation certificates except for a subset of houses built before 1995 in Miami-Dade County and before 1992 in Martin County, when these counties did not require elevation certificates. The post-FIRM premium rate for properties in AO and AH zones, which constitute 19.8% of our sample, additionally depends on whether a property has an elevation certificate. We test our model by alternatively assuming that no property had an elevation certificate, and results are robust to this assumption.

With the appropriate NFIP rate, we next recover the relevant insurance premium by applying this rate to the "building coverage." The building coverage amount is set as either the recorded loan amount or $250,000 (whichever is lower), given the NFIP coverage limits described above.[4] We assume no coverage for dwelling contents is purchased, because coverage for contents is not required. In addition, the value of the home's contents would not be capitalized into the home's price. Table 2 presents summary statistics for our calculated coverage and insurance premium. Based on our assumptions, the annual covered amount is $159,664 on average, with a median of $154,982. The full premium calculated prior to any discounts is, on average, $2,113 per year, with a median of $808. The pre-FIRM discounts, which are built into the NFIP rates, then provide an average discount of almost $1,000 relative to the full premium.

The next step in calculating flood insurance premiums for properties is to incorporate the CRS program discounts. NFIP lists the cities and counties that participate in the CRS, as well as their discount rates.[5] We match each house to the appropriate CRS community using GIS. We find that houses in our sample receive CRS discount rates of between 0 and 25 percent, with an average of 12 percent.

After characterizing housing properties, we lastly recover the race and income of buyers in our sales data so that we can categorize households into different "types." We merge the sales data with mortgage applications data, collected under the Home Mortgage Disclosure Act (HMDA),[6] which include (self-reported) race and income for the primary mortgage applicant.

[4] This assumes that homeowners purchase the minimum required building coverage. In our case, because our sales data are matched to mortgage applications in HMDA, and HMDA regulates reporting for federally regulated and backed lenders, SFHA houses in our data are required to cover the remaining principal on their mortgage, which is the initial loan amount as recorded in the application at the time of property sale.

[5] In Florida, county CRS rates cover rural areas within the county.

[6] Enacted by Congress in 1975, HMDA requires financial institutions, including depository institutions (e.g. banks and credit unions) and for-profit mortgage lending institutions, to make loan data publicly available. For reporting requirements in 2010, see https://www.ffiec.gov/hmda/reportde2010.htm.

The merge is based on loan information present in both of the data sources, and we follow the procedure outlined in Bayer et al. (2016). Key matching variables include the census tract of the property of interest, the application date, the loan amount, and the name of the lending institution. Household "types" are defined by race and income, where income is categorized into bins based on quintiles of the observed income distribution.

Some features of data availability and processing affect the final estimating sample. First, we lose Palm Beach County because no digitized flood map was available at the time of our analysis.[7] Second, we cannot match every property sale to a mortgage application and therefore cannot determine the race and income of homebuyers for a subset of transactions. The HMDA data allow us to recover matches for 47% of all housing transactions. We can, however, compare the race and income distributions for our merged data to the analogous distributions for owner-occupied housing from the 2013 American Housing Survey of Miami-Ft. Lauderdale-Hollywood, Florida, as shown in Table C.1. Compared to owner-occupied properties surveyed in the AHS, our HMDA-matched sample is quite similar, especially for the white, Asian, and Pacific Islander groups, which differ by less than 0.1%. Our HMDA sample has slightly fewer black households (11.9% versus 13.9%) and slightly more Hispanic households (38.9% versus 36.7%) relative to the AHS, but overall, the two samples are closely comparable. Median income for our sample of homeowners, at $64,000, is somewhat higher than median income for the general owner-occupied population, at $56,000. Our final sample includes 48,174 individual house sales between 2009 and 2012 across six counties and 953 census tracts in Florida. The six counties are Miami-Dade, Broward, St. Lucie, Martin, Indian River, and Okeechobee.

[7] In a phone interview, the NFIP representative described the digitization process as being prioritized by population density. However, these counties are more densely populated than other counties in Florida. Thus, the rationale for the omission is unclear.

B Hedonic Regressions

Table B.1 presents hedonic regressions of the annual rental price on house, flood, and other spatial attributes. The annual insurance premium subsidy is subtracted from annual rental prices to adjust for flood-insurance discounts. Each column represents a separate regression. Our coefficients of interest are those on the A and V zone indicator variables, denoted "A Zone" and "V Zone", that designate high flood risk status, where the omitted group is composed of X zone houses exposed to lower flood risk. All regressions include controls on house characteristics (house type indicators, number of bathroom, bedrooms, square foot, and age), neighborhood characteristics (Pre-FIRM, local environmental quality, school quality, distance to the nearest park and river), year fixed effects, and limit comparisons to be within county through the inclusion of county fixed effects. Columns (1) presents our base regression specification and columns (2) and (3) phase in additional controls for coastal amenity. Column (4) limits the sample to houses within 200 meters of a flood boundary and includes boundary fixed effects. Column (5) re-estimates the model in column (3), but uses annual rents that ignore the price supports that we calculate for each house.

In column (1), we present the hedonic estimates on flood zone and some basic spatial amenities. We find that house prices are approximately $1,096 lower for houses in the A zone relative to those in the X zone. However, houses in the V zone sell at a premium of $5,205, which is likely to be driven by the presence of coastal amenities. Moving to columns (2) and (3), we respectively add surface elevation, base flood elevation, and distance-to-coast bins, where the omitted category is houses farther than 5 kilometers from the coast. Notably, there is a very steep price gradient with respect to distance to the coast in column (3). With these controls, houses in A and V zones, respectively, sell for $593 and $1,437 lower than comparable houses in the X zone. While there may still be bias from unobserved coastal amenities (e.g. even within 0.1 kilometers, people may be willing to pay a significant premium for a house with a view of the ocean), the MWTP as measured from these regressions represent -5 and -13 percent of average housing prices in our sample (assuming a 5 percent discount rate), which is comparable to previous work.[8] We additionally assess the quality of our estimates by limiting our sample to houses within 200 meters of a flood boundary and re-estimating the model to include boundary fixed effects, following Black (1999), in column (4). Our MWTP estimate for A zone houses is very similar with and without boundary fixed effects (-$639 compared to -$593). However, the estimated coefficient on V zone is approximately 3.6 times larger, from -$1,437 to -$5,204. As only 0.2 percent of our houses are located in the V zone,

[8]For example, Harrison et al. (2001), Bin et al. (2008), Posey and Rogers (2010), and Zhang (2016) find that houses in flood prone areas sell for a price discount ranging between 5 and 11 percent.

this suggests that our WTP may still be attenuated for the small fraction of houses in coastal areas. Finally, in the last column of Table B.1, we re-estimate the model in column (3), but use annual rents that ignore the price supports that we calculate for each house. The A zone coefficient is positive at $147, and that for the V zone parameter is also attenuated (-$1,380). These differences point to the variation in discounts between zones and the extent to which ignoring price supports will matter for hedonic and sorting estimates.

Table B.1: Hedonic Regressions

Dep. Var.:	Account for Price Supports				Ignore Price Supports
Annual Rent	(1)	(2)	(3)	(4)	(5)
A Zone	-1,096***	-1,207***	-593.3***	-639.0***	147.0**
	(69.25)	(72.66)	(68.06)	(114.2)	(65.32)
V Zone	5,205***	4,120***	-1,437**	-5,204***	-1,380**
	(645.4)	(646.6)	(623.4)	(820.0)	(598.3)
Elevation		-333.6***	-238.3***	253.4***	-266.6***
		(26.81)	(25.08)	(69.67)	(24.07)
Relative BFE		235.0***	387.6***	693.0***	10.92
		(17.88)	(16.92)	(34.69)	(16.24)
Distance to Coast:					
<0.1km			10,694***	7,149***	10,513***
			(218.8)	(499.9)	(210.0)
<0.5km			9,794***	6,062***	9,737***
			(138.1)	(358.5)	(132.6)
<1km			7,851***	6,685***	7,320***
			(150.4)	(367.8)	(144.3)
<2km			4,619***	5,113***	4,596***
			(115.5)	(260.3)	(110.8)
<3km			2,518***	2,884***	2,847***
			(109.3)	(255.2)	(104.9)
<4km			1,655***	1,321***	1,894***
			(118.2)	(280.8)	(113.4)
<5km			1,216***	57.32	1,412***
			(116.4)	(263.8)	(111.7)
Observations	48,174	48,174	48,174	13,787	48,174
R-squared	0.552	0.555	0.618	0.721	0.652

Note. All regressions include county and year fixed effects. The (omitted) base group for flood zone is zone X. Controls not shown include house characteristics (house category indicators, number of bathroom, bedrooms, square foot, and age) and neighborhood characteristics (Pre-FIRM, ICR's within 3km, school quality, distance to the nearest park and river). Column (4) limits the sample to houses within 200 meters of a flood boundary and includes boundary fixed effects.

C Additional Tables

Table C.1: HMDA Merged Sample Comparison with 2013 American Housing Survey

Race/Ethnicity	AHS	HMDA	Income	AHS	HMDA
White	46.9%	46.8%	Median	56,000	64,000
Black	13.9%	11.9%			
Hispanic	36.7%	38.9%			
Asian	2.5%	2.5%			

Note. This table presents race and income distributions in our sample, following the HMDA merge, and compares them with owner-occupied household characteristics data from the 2013 American Housing Survey for the metro area of Miami-Ft. Lauderdale-Hollywood, Florida.

Table C.2: ACS Migration Flows (2009-2013)

Nature of Move:	Count of People	Share of Movers
Within County	524,864	69.8%
Within CSA (study area)	577,212	76.8%
Outside CSA	75,511	10.0%
Outside FL	98,699	13.1%
Total Movers:	751,422	

Table C.3: First Stage Estimates (N=48,174)

	Black	Hispanic	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Flood Zone	0.637	0.218	-0.017	-0.071	-0.146	-0.557
	0.047	0.030	0.038	0.040	0.040	0.038
BFE Assigned	-0.552	-0.368	0.111	0.195	0.449	1.032
	0.073	0.048	0.067	0.069	0.072	0.073
USGS Elevation	0.195	-0.008	-0.060	-0.079	-0.125	-0.233
	0.017	0.016	0.015	0.016	0.018	0.020
Coast<0.1km	-0.959	-0.480	0.172	1.016	1.532	2.462
	0.197	0.096	0.172	0.139	0.134	0.121
Income	-0.009	0.009	0.027	0.051	0.072	0.093
	0.002	0.001	0.002	0.002	0.002	0.002
Black	3.896	1.403	-0.625	-1.237	-2.027	-3.633
	0.126	0.122	0.096	0.119	0.156	0.272
Hispanic	-1.405	3.299	0.239	0.306	-0.067	-0.823
	0.150	0.084	0.088	0.093	0.090	0.101
School Quality	1.366	-1.812	1.374	1.608	1.618	1.390
	0.248	0.197	0.158	0.157	0.152	0.167
Dist. to River	0.219	0.166	0.065	0.072	0.077	0.092
	0.009	0.006	0.006	0.006	0.007	0.007
ICR within 3km	-0.111	-0.104	-0.036	-0.061	-0.072	-0.098
	0.013	0.010	0.011	0.011	0.011	0.012
Dist. to Park	0.038	0.022	0.008	0.004	-0.003	-0.006
	0.002	0.002	0.002	0.002	0.002	0.003

Note. This table presents first-stage estimates for heterogeneous sorting parameters (in utils) before conversion to a dollar value.

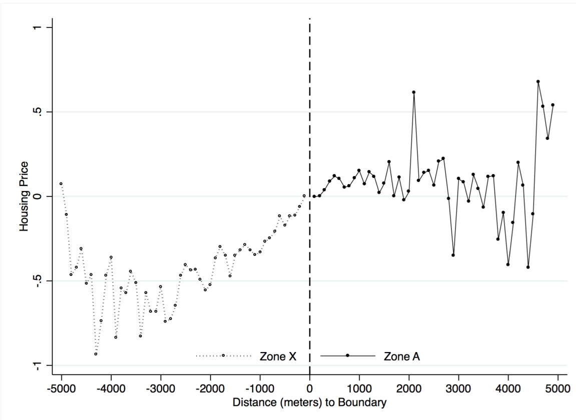
Table C.4: First Stage Estimates - Race by Income (Est/S.E.)

Race/Ethnicity:	White				Black				Hispanic			
Income Quartile:	Q1†	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Flood Zone	-1674.62	-19.90	-221.68	-638.73	708.14	1014.44	1047.29	871.12	430.22	311.21	79.19	-300.90
	23.02	75.50	71.66	70.81	98.04	114.67	143.82	209.29	78.85	79.73	82.47	89.18
BFE Assigned	-6534.55	217.19	545.95	1401.75	-534.50	-455.43	-574.05	-252.68	-562.10	-378.81	54.58	1082.37
	56.09	163.77	150.98	139.62	188.50	211.13	260.68	350.82	148.57	149.69	150.64	150.55
USGS Elevation	-57.78	-117.68	-201.72	-438.39	147.44	220.21	178.98	162.26	-89.23	-190.50	-243.47	-119.65
	7.36	26.89	26.89	28.46	36.13	45.10	60.30	94.01	33.15	36.92	39.38	41.51
Coast <0.1km	10301.24	1231.08	1835.01	3142.56	-2042.81	-439.90	278.08	2250.33	-232.22	-1063.45	1118.49	2389.67
	104.19	390.92	374.63	349.66	816.95	662.97	881.70	701.76	425.77	487.72	394.52	362.42
Income	215.09	16.91	65.13	102.42	-38.91	10.26	48.76	85.01	-5.44	33.77	74.91	103.50
	2.02	3.56	3.21	3.09	5.07	5.12	5.73	7.31	3.81	3.65	3.53	3.44
Black	-9085.11	-408.20	-1326.81	-3364.01	5766.03	5394.06	4504.38	3191.08	3429.26	1220.20	-147.15	-5178.78
	64.95	299.31	319.60	371.07	256.41	283.23	352.41	580.99	254.35	291.06	330.88	479.60
Hispanic	-3676.54	196.89	-102.59	-795.30	-1488.44	-2730.94	-2898.81	-1553.59	5159.49	5258.02	5100.69	3373.96
	57.77	267.58	250.24	239.37	368.77	454.80	625.11	747.92	221.22	220.84	217.90	231.97
School Quality	11676.52	1388.12	1953.05	1388.65	1107.64	4312.51	2401.89	1283.87	-3247.27	-970.75	-323.51	-857.16
	384.44	245.85	249.23	264.90	443.71	694.02	833.60	1085.73	391.99	448.12	494.81	549.15
Dist. to River	-418.58	25.22	39.85	26.92	246.07	410.54	325.27	284.07	160.63	265.98	262.47	394.99
	8.99	10.76	10.46	10.54	15.77	23.42	29.64	38.80	13.23	15.73	17.37	19.30
ICR	-96.49	23.80	17.07	-27.73	-49.58	-189.30	-205.16	-132.68	-33.86	-105.14	-274.72	-209.70
	5.54	20.33	19.74	20.06	26.21	35.04	46.84	66.36	21.87	23.82	28.84	30.95
Dist. to Park	-101.14	-3.34	-5.82	-26.29	42.91	70.16	41.49	18.31	18.66	32.84	10.63	45.16
	1.76	3.17	3.22	3.59	4.43	5.95	7.99	12.43	4.34	5.01	5.61	5.92

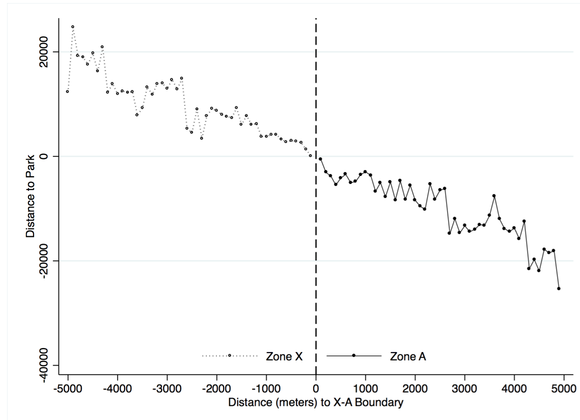
Note. This table presents heterogeneous MWTP estimates, where households are categorized into race-by-income-quartile groups. † represents the base group. Estimates for non-base group categories should be added to the base group estimate to recover the preference for that group.

D Additional Figures

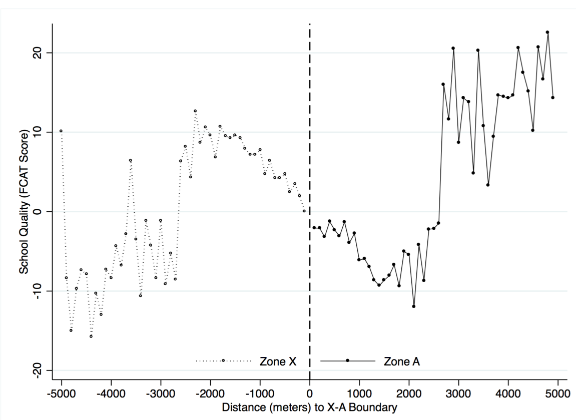
Figure D.1: Price and Spatial Amenities by Distance to Flood Boundary



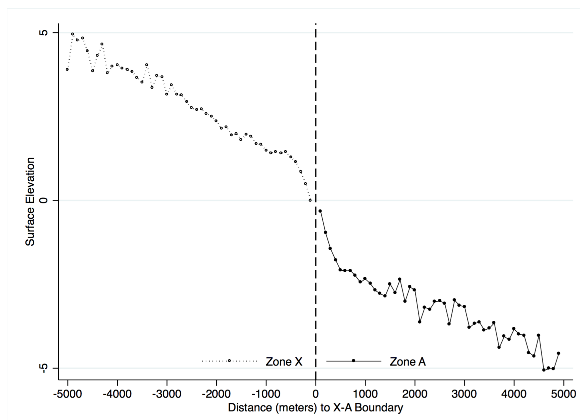
(a) Housing Price



(b) Distance to Nearest Park



(c) School Quality



(d) Surface Elevation

Note. Each figure plots the coefficients from a regression of a spatial attribute against distance-to-flood boundary dummy variables at 100-meter increments from the X zone (on the left) to the A zone (on the right). Point estimates are normalized to zero at the 100-meter distance on the X side of the boundary. Figure D.1 supports previous researchers' observations that houses in higher risk areas seem to sell at a premium compared to their lower risk counterparts. Compared to the overall average of characteristics on high and low risk sides of the flood boundary, A zone properties have higher levels of attributes that would generally be considered attractive: houses in those regions are, among other traits, closer to parks and have higher school quality as proxied by FCAT scores. Moreover, the lower surface elevation in the higher risk A areas is indicative of access to water-based amenities that would also be an important contributor to price.

References

Bayer, P., F. Ferreira, and R. McMillan (2007). A unified framework for measuring preferences for schools and neighborhoods. *Journal of Political Economy 115*(4), 588–638.

Bayer, P., R. McMillan, A. Murphy, and C. Timmins (2016). A dynamic model of demand for houses and neighborhoods. *Econometrica 84*(3), 893–942.

Bin, O., J. B. Kruse, and C. E. Landry (2008). Flood hazards, insurance rates, and amenities: Evidence from the coastal housing market. *Journal of Risk and Insurance 75*(1), 63–82.

Black, S. E. (1999). Do better schools matter? Parental valuation of elementary education. *Quarterly Journal of Economics 114*(2), 577–599.

Epple, D. and H. Sieg (1999). Estimating equilibrium models of local jurisdictions. *Journal of Political Economy 107*(4), 645–681.

FEMA (2013). National flood insurance condominium coverage. *Available online at* $https://www.fema.gov/media-library-data/20130726-1450-20490-0505/f029_condocov0410.pdf$.

Flood Smart (2016). National flood insurance program. Available online at: $https://www.floodsmart.gov/floodsmart/$.

Harrison, D., G. T. Smersh, and A. Schwartz (2001). Environmental determinants of housing prices: The impact of flood zone status. *Journal of Real Estate Research 21*(1-2), 3–20.

Logan, J. R., Z. Xu, and B. J. Stults (2014). Interpolating us decennial census tract data from as early as 1970 to 2010: A longitudinal tract database. *The Professional Geographer 66*(3), 412–420.

NFIP (2016). National flood insurance program flood insurance manual. Available online at: $https://www.fema.gov/media-library/assets/documents/127010$.

Posey, J. and W. H. Rogers (2010). The impact of special flood hazard area designation on residential property values. *Public Works Management & Policy 15*(2), 81–90.

Rabines, A. (2018). In miami beach, buyers and builders turn to elevated homes amid rising concerns of floods. *Available online at* $https://therealdeal.com/miami/2018/12/21/in-miami-beach-buyers-and-builders-turn-to-elevated-homes-amid-rising-concerns-of-floods/$.

Zhang, L. (2016). Flood hazards impact on neighborhood house prices: A spatial quantile regression analysis. *Regional Science and Urban Economics 60*, 12–19.