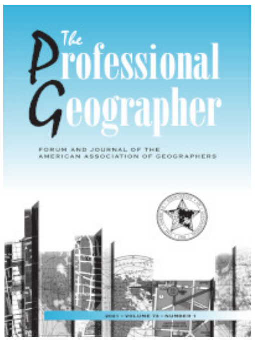

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Sea Level Rise, Homeownership, and Residential Real Estate Markets in South Florida

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This article builds on a small but rapidly growing body of research that seeks to determine the impact of sea level rise on the pricing of residential properties. Through a spatial hedonic regression analysis of real estate markets in two Florida counties (Miami–Dade and Pinellas), we assess the influence of different exposure levels on market discounts. Our article stands out in terms of its focus on two comparative case studies and its differentiation between properties that are primary homes versus nonprimary homes. We find that generally discounts are positively associated with exposure levels and overall Miami–Dade experiences higher discounts than Pinellas due to the former's lower average elevations. We also observe different market behaviors of primary versus nonprimary home buyers and these are partially dependent on affluence. In Miami–Dade, price discounts are less for highly priced properties purchased by nonprimary owners. We attribute this to different buying motives and risk tolerance of affluent nonprimary homeowners. We argue that nonprimary ownership, particularly in high-end waterfront residential real estate, is tempering gradual market adaptation to sea level rise exposure risk, which could have detrimental longer-term consequences in terms of market volatility. **Key words: Florida, homeownership, real estate, risk, sea level rise.**

There is no doubt that sea level rise (SLR) is real and accelerating. In many locations along the U.S. coastline, high-tide flooding in 2019 was three to nine times more common than fifty years earlier (Lindsey 2019). Most projections indicate a 2–6 ft rise (0.6–1.8 m) by 2100 (Intergovernmental Panel on Climage Change 2013; Lindsey 2019). According to recent estimates, by 2050 some 340 million people worldwide could find themselves on land below projected annual flood levels, and by the end of the century the number could reach 630 million (Kulp and Strauss 2019).

SLR, especially when combined with storm surges, poses major challenges for low-lying coastal cities around the world (Sallenger, Doran, and Howd 2012). Mitigation and adaptation efforts are needed to keep up with the pace of rising sea levels but are often cost-prohibitive and, consequently, many people, particularly those in peripheral urban areas, will be forced to retreat (Hinkel et al. 2014; Woetzel et al. 2020). SLR thus has profound implications for coastal communities internationally.

In the United States and elsewhere, the coastal real estate market is quickly becoming a focal point of discourses and research because of the market's importance to coastal economies (Bin et al. 2011; Fuerst and Warren-Myers 2019). Also, real estate is by far the largest asset for most American households, which implies a growing risk to the financial well-being of large populations. It is not a question of *whether* but *when* and *how* exposed real estate markets will respond.

Clearly, the more benign scenario is one of gradual responses that distribute costs over time and across markets. However, it is unlikely that market responses run neatly parallel to (or in measured anticipation of) incremental SLR trends because of inherent volatilities of mass market behavior; for example, in reaction to extreme weather events such as hurricanes or sudden changes in the institutional environment related to mortgages or home insurance. There is, in fact, evidence of major price adjustments in the wake of extreme weather events (see, e.g., McKenzie and Levendis 2010; Ortega and Taspinar 2018; Beltrán, Maddison, and Elliott 2019; Chandra-Putra and Andrews 2020). There is also a growing likelihood of shock effects through sudden adjustments in home lending and insurance that could lead to rapidly declining home values (Flavelle 2019). It is all the more important, then, that markets exhibit steady and anticipatory responses to the threats of SLR to avoid extreme price swings in the future (Bernstein, Gustafson, and Lewis 2019).

Existing Research

Though there is a considerable literature on aggregate estimates of the financial cost of future flooding due to SLR (e.g., Fu et al. 2016) and on the effect of current flood zone locations on pricing (e.g., Bin

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and Kruse 2006; Beltrán, Maddison, and Elliott 2019), little research has been done on price adjustment in the face of anticipated vulnerability due to SLR. Moreover, the existing research is not conclusive. Some observe pricing discounts attributed to SLR exposure risk (Keenan, Hill, and Gumber 2018; Bernstein, Gustafson, and Lewis 2019), but others find no effect (e.g., Fuerst and Warren-Myers 2019; Murfin and Spiegel 2020).

Comparing existing studies on this topic is difficult because of the use of different data sets, over varying time periods, covering different geographies, and employing different methodologies and/or measures of exposure to SLR. For example, the abovementioned studies by Bernstein, Gustafson, and Lewis (2019) and Fuerst and Warren-Meyers (2019) focus on, respectively, all coastal counties in the United States and a relatively small coastal community near Melbourne, Australia. Though a single case study is limited in terms of generalizable findings, large aggregated data sets such as those covering the entire United States may obfuscate possibly significant regional differences in terms of physical geographical configurations (e.g., inland waterways, relief, or land subsidence/rebound), prices for coastal properties, the incidence of nonprimary homeownership, and the presence of foreign buyers.

The main hypothesis in the literature postulates that, all other things being equal, properties exposed to SLR are priced lower than properties that are not (or to a lesser degree) exposed because buyers (and sellers) take the exposure risk into consideration. A key question is, of course, how much weight the market gives to SLR exposure risk, and this may vary from agent to agent (buyers and sellers), neighborhood to neighborhood, region to region. Some studies emphasize the importance of agents' awareness of and information about SLR exposure risk of a particular property as a key determinant of discount rates, but here, too, the findings diverge. For instance, Giglio, Maggiore, and Stroebel (2015) and Gibson, Mullins, and Hill (2019) find a positive effect of information about future SLR exposure risk on discounts, whereas Filippova et al. (2019) do not. The latter finding suggests that market behaviors are driven not only by information about SLR per se but also by beliefs in mitigation technologies (and their affordability) to delay the actual impact of SLR (Flavelle and Mazzei 2019; Murfin and Spiegel 2020).

Of particular importance to our research is the paper by Bernstein, Gustafson, and Lewis (2019), who propose that buyers who are "non-owner occupiers" tend to be more "sophisticated" agents; that is, they are more aware of SLR exposure risks. Indeed, they find an average discount of 10 percent for non-owner occupiers compared to 4 percent for owner-occupiers. Non-owner occupiers are thought to be more sophisticated (aware, informed) because they often buy for investment purposes and "come from zip codes with higher education levels and income" than owner-occupiers (Bernstein, Gustafson, and Lewis 2019, 255). The authors reason that "more sophisticated buyers will demand a discount for SLR risk … this discount will depend less on regional beliefs and more on the scientific community's projections regarding SLR risks."[1] Theoretically, we agree that some buyers (such as investors who do not intend to live in the purchased property) may be more informed than others, and this can influence their decision making on a possible purchase. But we desist from the notion of "sophistication," especially if applied to entire categories of owner-occupiers versus non-owner occupiers. Surely, education and income are questionable predictors of awareness about SLR and even more so of beliefs in climate change (Palm and Bolson 2020).[2] More pertinent, we suspect that among owner-occupiers there are likely to be important differences in market behavior depending on whether they are first or second homeowners. These differences relate to motives and risk calculations and may be especially apparent between affluent nonprimary home buyers and less affluent primary home buyers.

The National Association of Realtors reported in 2018 that 8 percent of the dollar volume of residential real estate purchases in the United States came from foreign buyers, but in the state of Florida the foreign share was nearly one-fifth. The median purchase price for foreign buyers in Florida was 20 percent higher than that for non-foreign buyers. And this price difference varies considerably across the state: the report notes that over half of all of Florida's foreign buyers are concentrated in the expensive Miami–Fort Lauderdale–West Palm Beach area. Two-thirds of all home purchases in Florida by foreign buyers are made in cash. Even though we are not able to include the foreign status of buyers in our model, we do know that they are an important subset of nonprimary home buyers, especially in Miami–Dade County. We also know from previous research that nonprimary homeownership in Miami–Dade is particularly salient in the expensive ZIP codes along the water front (Nijman 2011).

Thus, though we accept the findings in Bernstein, Gustafson, and Lewis (2019) that indicate that investor buyers are likely to negotiate higher discounts for SLR-exposed properties, we think that there is another market behavior in play, namely, that of affluent nonprimary homeowners who do tend to occupy the home. We suspect that this is of particular importance in high-end coastal residential real estate markets such as Miami–Dade County.

Conceptual Framework

Our theoretical framework builds on the small but rapidly growing body of research on the impacts of

SLR on real estate markets. First, as we indicated above, existing studies are still small in number and the divergent findings may in part be due to different geographic foci, varying time periods, different study designs, and different data sets. Our study builds in part on a literature in urban studies that underscores the theoretical and methodological values of comparative approaches (Dear 2005; Nijman 2007a, 2015; Ward 2008; McFarlane 2010). We use a single and consistent research design, but the empirical focus is on two South Florida counties with different demographics and real estate market segments.

Second, our study is also original in the focus on the potentially different roles of primary and nonprimary homeowners. Based on the existing social science literature on homeownership, we articulate different *motives* of primary versus nonprimary home buyers (e.g., Saunders 1990). In addition, based on the existing literature in real estate and market behavior, we argue that primary and non-primary home buyers, assuming that the latter are more affluent, are likely to have a different *risk tolerance* (e.g., Grable 2000). Together, these different dispositions are expected to result in different market behaviors.

More precisely, our conceptual framework is based on the following assumptions:

1. SLR exposure risk is defined in terms of elevation and distance from the coastline.
2. Discounts are defined as the price difference between comparable properties (all within a 5,000-ft (1524 m) distance from the coast) that differ only (or mainly) in the extent of SLR exposure risk.
3. Nonprimary homeowners (NPHOs) are defined as owners who have no homestead exemption according to county government assessor records. Such owners are assumed to have their primary home elsewhere.
4. We expect a higher SLR exposure risk of a property to result in a higher price discount.
5. In the most expensive market segments, we expect exposed properties bought by primary homeowners (PHOs) to have higher discounts than properties bought by NPHOs due to
   a. Different purchasing motives: Generally, PHOs buy a property as a long-term proposition, are motivated by long-term attachment to the home (e.g., jobs, schools, and social engagement) and investment returns, and will be sensitive to long-term risk (e.g., Saunders 1990); Most affluent NPHOs generally are motivated by short- or medium-term interest in acquiring property, placing a premium on immediate returns in terms of amenities and quality of living (i.e., waterfront property).
   b. Differences in risk tolerance: Assuming that NPHOs are wealthier and have other long-term investments (a primary home elsewhere, in any case) to secure financial stability, they are more financially flexible, more mobile, and less socially invested in the home or neighborhood (e.g., Friedmann 1998; Nijman 2007b) and, as such, better positioned to sell in the short or medium term if impelled by a changing market.

Case Studies, Methods, Data

We use a comparative approach with an empirical focus on two Florida counties, Miami–Dade and Pinellas, located on the southeast and southwest coasts of the state, respectively. Miami–Dade County has figured prominently in media reports and academic studies on the impacts of sea level rise. It also has large numbers of affluent second homeowners (Nijman 2011; National Association of Realtors 2018), adding importance to the inclusion of another case study area, Pinellas County, to allow for a comparative perspective. Table 1 summarizes some important characteristics of the two counties in terms of topography, demographics, and real estate values.

Both counties have considerable residential real estate exposed to SLR and both have substantial numbers of NPHOs (33.6 percent of all buyers in Pinellas, 35.4 percent in Miami–Dade). But the two counties have different topographies (Pinellas has a wider range and higher average of elevations and a longer coastline); different population sizes (Miami–Dade's population is about two-and-a-half times that of Pinellas); different population compositions (Pinellas's population is older and Miami–Dade's is much more international); differently segmented real estate markets (Miami–Dade is considerably more expensive, with an average house price of $478,300 compared to $279,800 in Pinellas); and Miami–Dade has many more foreign NPHOs (according to National Association of Realtors [2018] estimates, six times as many in absolute terms). Thus, though the two counties have a comparable share of NPHOs, second home-owners in Pinellas are more often from the United States, are older, and appear less affluent. This "snowbird" profile of many NPHOs seems to be confirmed in the much larger presence of mobile homes in Pinellas (Table 1). The literature indicates that since around 1990, Miami–Dade has been a rapidly declining destination for traditional snowbirds,

Table 1 *Selected county-wide characteristics of Miami–Dade and Pinellas*

	Pinellas County	Miami–Dade County
Est. average elevation/range of elevation	30 ft/0–110 ft (≈ 9 m/0–34 m)	6 ft/0–34 ft (≈ 2 m/0–10 m)
Coastline length	588 miles (≈ 946 km)	84 miles (≈ 135 km)
Total population, 2018	975,280	2,761,581
Percentage foreign born population, 2018	12%	53%
Percentage households where other language than English is spoken at home, 2018	14%	74%
Percentage population over age 65, 2018	25%	16%
Average house price 2004–2019	$297,800	$478,300
Percentage PHOs county-wide, 2004–2019	66.4%	64.6%
Percentage NPHOs county-wide, 2004–2019	33.6%	35.4%
Percentage mobile homes of all housing units (2010)	10.4%	1.8%

Notes: Prices are adjusted to 2019 US dollars. PHO = primary homeowner; NPHO = nonprimary homeowner.
Sources: Topography (Miami Dade n.d.-a; Pinellas County n.d); population (U.S. Census Bureau n.d.); prices (Miami Dade n.d.-b; Pinellas County Property Appraiser n.d.); mobile homes (Desrosiers-Lauzon 2011).

Table 2 *Basic characteristics of home sales in the two case study samples (i.e., single-family homes within 5,000 ft [1,524 m] coastal bands of Miami–Dade and Pinellas counties) 2004–2019*

	Pinellas County	Miami–Dade County
Number of home sales (*N*)	77,454	58,264
Percentage PHOs	66.3%	60.4%
Percentage NPHOs	34.7%	39.6%
Average house price	$322,200	$613,800
Average house price for PHOs	$333,300	$568,200
Average house price for NPHOs	$300,300	$683,100

Notes: Prices are adjusted to 2019 US dollars. PHO = primary homeowner; NPHO = nonprimary homeowner.
Source: County Appraiser's Offices.

mainly due to its increasingly expensive real estate (Desrosiers-Lauzon 2011).

Within the two counties, we concentrate our study on 5,000-ft coastal bands to capture the most exposed residential real estate.[3] Table 2 shows that within these samples, the differences between the two counties are even more pronounced: within the 5,000-ft coastal bands, the average house in Miami–Dade is nearly twice as expensive as in Pinellas. Also, in Miami–Dade the average house price of NPHOs is considerably higher than that of PHOs but in Pinellas NPHOs' prices are slightly *below* that of PHOs.

Property sales transaction data were retrieved from the property appraiser offices in the two counties, covering the period from January 2004 to March 2019. We selected only detached single-family homes because of the differently perceived exposure risk vis-à-vis condos and to enable proper comparison between the counties (Miami–Dade has a much larger share of condos than Pinellas). Subsequently, a 5,000-ft distance band was applied to focus our data sample solely on coastal properties.

We employed a spatial hedonic regression model to gauge the price effect of SLR exposure risk under incremental scenarios from 2 ft to 6 ft (0.6 to 1.8 m) elevation. Hedonic modeling is commonly used to examine property price differentials in real estate studies (Cohen and Coughlin 2008; Anselin and Lozano-Gracia 2009; Bin et al. 2011). Spatial autocorrelation/dependency is important to consider in hedonic studies to avoid biased and inconsistent results (Anselin and Bera 1998; Kim, Phipps, and Anselin 2003; Ekeland, Heckman, and Nesheim 2004). A pretest of spatial autocorrelation in our data set rendered values of Moran's I in both counties that suggest strong spatial dependence in the dependent variable (property prices) with over 99.9 percent confidence.

Thus, we used a spatial autoregressive regression model to explicitly consider the spatial effects in estimating the hedonic regression. The spatial hedonic model equation[4] can be written as follows:

$$\mathbf{P} = \rho \boldsymbol{WP} + \boldsymbol{X\beta} + \varepsilon,$$

where $\mathbf{P}$ is a vector of hedonic housing prices; ρ is a spatial autocorrelation parameter; $\boldsymbol{W}$ is an n by n spatial weight matrix (where n is the sample size); $\boldsymbol{X}$ is a matrix of independent variables and contextual variables that absorb variations in housing prices relating to the year of sale and sale location; $\boldsymbol{\beta}$ is a matrix of variable coefficients; and ε is a vector of random error terms.

In this model, the dependent variable is the housing price and key independent variables are the SLR exposure dummies, which were spatially analyzed by whether the centroid point of a property would be within a future SLR exposure layer under various scenarios. Besides the property characteristic variables that are available from the initial property data set, other independent variables are based on data from the two counties geographic information systems departments, Federal Emergency Management Agency (FEMA) GIS Data, and the National Oceanic and Atmospheric Administration's Sea Level Rise Viewer, all processed in the ArcGIS spatial environment (see Table 2). It should be noted that because we introduced a year of sale dummy variable into our model, housing prices were unadjusted to avoid compound effects.

The regression analysis proceeds in two steps: first, we examine overall discounts under incremental SLR exposure risk. Next, to differentiate between PHOs and NPHOs, two ownership interaction

Table 3 *Summary statistics for regression variables for Pinellas County and Miami–Dade County*

	Pinellas County (*N* = 77,454)		Miami–Dade County (*N* = 58,264)	
	Mean	Std. dev.	Mean	Std. dev.
Housing price (×10^3 US$, unadjusted)	292	264	555	849
Number of bedrooms	1.93	1.12	3.26	0.96
Lot size (×10^3 sq. ft$^+$)	2.47	1.26	9.29	19.49
Living area (×10^3 sq. ft$^+$)	1.76	0.85	2.04	1.20
Year property built (as compared to year 2019)	42.67	19.92	46	40
Distance to coast (×10^3 ft^{++})	1.91	1.43	2.09	1.45
Distance to major road (×10^3 ft^{++})	1.99	2.06	0.94	0.80
FEMA floodplain	0.33	0.47	0.48	0.50
SLR exposure (6 ft or 1.8 m)	0.21	0.40	0.32	0.47

Notes: $^+$1 sq. ft = 0.0929 sq. m; $^{++}$1 ft = 0.3048 m. FEMA = Federal Emergency Management Agency; SLR = sea level rise.

Table 4 *Spatial hedonic regression results for Pinellas County and Miami–Dade County*

	Pinellas County		Miami–Dade County	
Variables	**Coefficient**	**Std. error**	**Coefficient**	**Std. error**
Intercept	2.50***	0.02	2.70***	0.03
Number of bedrooms	0.03***	7.2×10^{-4}	0.04***	0.002
Lot size, sq. ft$^+$	0.07***	0.003	0.001***	8.4×10^{-5}
Living area, sq. ft$^+$	0.18***	0.004	0.23***	0.002
Year property built	-1.20×10^{-4}.	6.8×10^{-5}	-1.40×10^{-4}***	4.2×10^{-5}
Euclidean distance to coastline, ft^{++}	−0.01***	9.4×10^{-4}	−0.03***	0.001
Euclidean distance to major road, ft^{++}	0.01***	6.0×10^{-4}	0.01***	0.002
FEMA 100-year floodplain	0.05***	0.004	−0.03***	0.004
SLR exposure less than 2 ft^{+++}	−0.12***	0.02	0.02	0.03
SLR exposure 2 to 3 ft^{+++}	−0.02*	0.01	−0.07***	0.01
SLR exposure 3 to 4 ft^{+++}	0.03***	0.01	−0.03***	0.01
SLR exposure 4 to 5 ft^{+++}	0.06***	0.01	−0.01	0.01
SLR exposure 5 to 6 ft^{+++}	0.04***	0.01	−0.01*	0.005
ρ	0.45***	0.003	0.47	0.004
R^2	0.79		0.81	
Log-likelihood	−14,156.1		−25,291.4	
Moran's *I*	308.68 ($p < 0.001$)		228.15 ($p < 0.001$)	
Sample size	77,454		58,264	

***$p < 0.001$;
**$p < 0.01$;
*$p < 0.05$;
.$p < 0.1$.
Notes: Year and city/town dummies were included in the model but omitted here for simplicity;
$^+$1 sq. ft = 0.0929 sq. m; $^{++}$1 ft = 0.3048 m; $^{+++}$2 ft ≈ 0.6 m, 3 ft ≈ 0.9 m, 4 ft ≈ 1.2 m, 5 ft ≈ 1.5 m, 6 ft ≈ 1.8 m.
FEMA = Federal Emergency Management Agency; SLR = sea level rise.

terms are introduced into the prior model specification: if the owner (buyer) of a property is a primary homeowner, the interaction term for the PHOs equals 1 and 0 otherwise; the same applies to the NPHOs. All computations were processed in GeoDa, an open source spatial econometric software.

Results

Table 3 provides summary statistics of our samples in both counties. Note again that the mean home values are nearly twice as high in Miami–Dade, and homes and especially lot sizes in Miami–Dade are bigger. The presence of very expensive coastal real estate in Miami–Dade also causes the standard deviation to be higher than in Pinellas. The average distance to the coast is about the same in both counties, but Miami–Dade properties tend to be relatively more exposed: more homes are located in FEMA flood zones and more are located below 6-ft elevations, despite Pinellas having a considerably longer coastline.

The overall regression results for the two counties, without distinction between primary and non-primary homeownership, are shown in Table 4. Note that the price discounts are overall higher in Miami–Dade than in Pinellas, which can be explained by Miami–Dade's greater overall vulnerability due to its considerably lower elevations. This probably also explains why a FEMA flood plain location in Miami–Dade shows a discount, whereas in Pinellas it does not.[5] But what is the relationship between SLR risk exposure at various levels and pricing within the two counties?

In Pinellas, we observe a progressively higher discount at increased SLR exposure levels, as hypothesized. The discount is by far the highest, 12 percent, for the most exposed properties below 2 feet. The discount is 2 percent at 2–3 ft exposure. Above 3 ft, there is actually already a price markup (negative discount): 3 percent at 3–4 ft, 6 percent at 4–5 ft, and 4 percent at 5–6 ft. In Miami–Dade, however, we observe *no* significant discount for the most exposed properties (<2 ft), but we do see 3 to 7 percent discounts between 2 and 5

Table 5 *Spatial hedonic regression results for PHOs and NPHOs in Pinellas County and Miami–Dade County*

Variables	Pinellas County Coefficient	Pinellas County Std. error	Miami–Dade County Coefficient	Miami–Dade County Std. error
Intercept	2.50***	0.02	2.70***	0.03
Number of bedrooms	0.03***	0.001	0.04***	0.002
Lot size, sq. ft+	0.07***	0.003	0.001***	8.4×10^{-5}
Living area, sq. ft+	0.18***	0.004	0.23***	0.002
Year property built	-1.2×10^{-4}.	6.8×10^{-5}	1.4×10^{-4}***	4.2×10^{-5}
Euclidean distance to coastline, ft++	−0.01***	0.001	−0.03***	0.001
Euclidean distance to major road, ft++	0.01***	0.001	0.01***	0.002
FEMA 100-year floodplain	0.05***	0.004	−0.03***	0.004
SLR exposure less than 2 ft & PHOs+++	−0.10***	0.03	−0.15***	0.05
SLR exposure less than 2 ft & NPHOs+++	−0.13***	0.03	0.14***	0.04
SLR exposure 2 to 3 ft & PHOs+++	−0.01	0.01	−0.09***	0.02
SLR exposure 2 to 3 ft & NPHOs+++	−0.03***	0.01	−0.05***	0.02
SLR exposure 3 to 4 ft & PHOs+++	0.05***	0.01	−0.06***	0.01
SLR exposure 3 to 4 ft & NPHOs+++	−0.01	0.01	0.003	0.01
SLR exposure 4 to 5 ft & PHOs+++	0.08***	0.01	−0.002	0.01
SLR exposure 4 to 5 ft & NPHOs+++	0.002	0.01	−0.01	0.01
SLR exposure 5 to 6 ft & PHOs+++	0.05***	0.01	−0.003	0.01
SLR exposure 5 to 6 ft & NPHOs+++	0.01.	0.01	−0.02***	0.01
ρ	0.45***	0.003	0.47***	0.004
R^2	0.79		0.81	
Log-likelihood	−14,083.7		−25,265.1	
Moran's *I*	308.55 (p < 0.001)		228.05 (p < 0.001)	
Sample size	77,454		58,264	

****p* < 0.001;
***p* < 0.01;
**p* < 0.05;
.*p* < 0.1.
Notes: Year and city/town dummies were included in the model but omitted here for simplicity;
+1 sq. ft = 0.0929 sq. m; ++1 ft = 0.3048 m; +++2 ft ≈ 0.6 m, 3 ft ≈ 0.9 m, 4 ft ≈ 1.2 m, 5 ft ≈ 1.5 m, 6 ft ≈ 1.8 m.
PHO = primary homeowner; NPHO = nonprimary homeowner; FEMA = Federal Emergency Management Agency; SLR = sea level rise.

ft; dropping to 1 percent above 5 ft. Miami–Dade does not see any substantial discounts above 4 ft. Below, we return to the apparent anomaly in Miami–Dade of no discounts for the most exposed properties.

In the next step of the analysis, we differentiate the impact of SLR exposure between PHOs and NPHOs. Table 5 shows the regression results with quite opposite patterns in the two counties. In Miami–Dade County, discounts are mostly higher for PHOs than for NPHOs, confirming our hypotheses. However, in Pinellas County, it is NPHOs' properties that exhibit higher discounts. For the most exposed properties in Pinellas, the discounts for PHOs and NPHOs are, respectively, 10 percent versus 13 percent; at 2–3 ft exposure, they are 1 percent versus 3 percent; and at 3–4 ft exposure the differences are a 5 percent price markup versus a 1 percent price discount.

In Miami–Dade, the findings for the most exposed properties are especially revealing. Properties below 2 ft show a substantial 15 percent discount for PHOs but no significant discount for NPHOs. Thus, the lack of an aggregate discount for the most exposed properties in Miami–Dade (see Table 4) can be attributed to the large presence of NPHOs. Our data show that 58 percent of all buyers in this segment are NPHOs, with an average value of NPHO properties of $1.7 m versus $1.2 m for PHOs. These prices are much higher than in Pinellas (NPHO properties below 2 ft in Miami Dade are 4.6 times as expensive as in Pinellas). Moreover, in Pinellas, NPHOs are a minority and NPHO homes are priced *lower* than PHO homes. In Miami–Dade, properties between 2 and 3 ft show discounts of 9 percent for PHOs vs. 5 percent for NPHOs, and properties between 3 and 4 ft show discounts of 6 percent for PHOs vs. no significant discount for NPHOs.

Discussion and Conclusions

Our findings are generally consistent with recent writings insofar as they indicate a price differential based on SLR exposure (e.g., Keenan, Hill, and Gumber 2018).[6] At the same time, our study contributes important new insights in the significance of geographic variations of real estate markets (Miami–Dade vs. Pinellas) and in the roles of nonprimary homeownership in market responses to SLR exposure.

The results indicate that SLR exposure risk is currently impacting the residential real estate markets in Pinellas County and Miami–Dade County, with generally higher discounts for more exposed properties. We find significant heterogeneity in the degree and extent of the discounting effect between the two counties: Miami–Dade shows a stronger overall market response in price discounts than Pinellas, which we attribute to Miami–Dade's greater county-wide exposure risk, due to its considerably lower county-wide elevations. Miami–Dade's average elevation is 6 ft (1.8 m), compared to 30 ft (9 m) in Pinellas. Pinellas's main cities, Saint Petersburg and Clearwater, have average elevations of 42 ft (13 m) and 32 ft (10 m), whereas the average elevation of the City of Miami is less than 7 ft (2.1 m). Buyers in Pinellas have more options than in Miami–Dade to purchase homes at higher elevations. Concern about SLR exposure is likely to be more widely shared in Miami–Dade than in Pinellas, and Miami–Dade has figured more prominently in media reports and academic debates about sea level rise.

But market responses to SLR are also limited: In Pinellas, discounts are limited to properties below 3 ft of exposure and properties between 3 and 6 ft elevation actually see a price markup. In Miami–Dade, we observe price discounts across the different exposure levels *except* for the most exposed properties, below 2 ft. The risk of SLR seems to be inconsequential in Miami–Dade's most exposed market segments. We attribute this to the different buyer motives and risk tolerance in this segment: these buyers are disproportionately affluent and nonprimary homeowners.

Interestingly, we find that the role of second homeowners (NPHOs) varies between the two counties: in Pinellas, second homes have higher discounts than primary homes, and this appears to align with the findings of Bernstein, Gustafson, and Lewis (2019). Here, it is possible that a significant number of NPHOs are in fact investors who take a more critical look at SLR-exposed properties and negotiate prices down and rent out the property. Accordingly, in Pinellas, our hypothesis does not hold up. We should note again that across all exposure levels in the Pinellas sample, NPHO prices are lower than PHO prices, indicating that PHOs in Pinellas tend to be the more affluent buyers.

In Miami–Dade, the pattern is reversed: there, the discounts for second homes are consistently *less* than those for primary homes. In Miami–Dade, with large numbers of second home buyers in very expensive market segments, our theoretical premise seems validated: PHOs are generally more deeply invested in the community than NPHOs, who typically reside elsewhere for much of the time. PHOs are likely to be more concerned with long-term stability, whereas NPHOs are generally invested in these properties in the short to medium term, with an eye on the immediate returns in terms of coastal amenities and quality of life. NPHOs are also wealthier buyers with a higher risk tolerance; thus, they are more financially flexible, more mobile, and less socially invested in the community.[7]

Hence, in Miami–Dade County, we find that nonprimary homeownership tends to dampen market adjustments to present and future SLR. The financial flexibility and mobility of many (affluent) NPHOs underlies their market behavior: at the present time, it allows ignoring projected SLR exposure and continued preferences for waterfront properties, but at some point in the foreseeable future it is likely to trigger an exodus from the same properties. Hence, present-day intransigence could have detrimental longer-term consequences in terms of market volatility. These findings may well apply to other coastal residential real estate markets, many of which have a substantial share of affluent NPHOs.

What are the planning implications of our findings? First, our study joins several others that observe market reactions to SLR risk exposure. We can expect these market reactions to continue and probably accelerate. This signals a challenge to many coastal cities that rely heavily on their housing markets for tax income. Most of these communities have yet to implement significant adaptations such as elevating roads, changing building codes, etc. (Fu et al. 2017, 2019; Fu 2020). Such adaptation is costly and will become more difficult to finance if market values of coastal properties and the tax base decline. This means that the proverbial clock is ticking for these communities to proceed with adaptation measures.

Second, it is striking that property owners in Pinellas (except at the highest exposure levels, below 2 ft) appear so much less concerned with SLR compared to Miami–Dade, a discrepancy we attribute in part to Pinellas having received far less attention in the news media and public debates about SLR compared to Miami–Dade. A Google search in July 2020 on "sea level rise Miami–Dade" returned about twelve times as many results as "sea level rise Pinellas." This apparent gap in risk perception calls for targeted information for the general public and local communities in Pinellas and similarly affected areas. Local workshops on SLR and public engagement with adaptation planning are also desired but not yet widespread or common.

Finally, our findings suggest that governments at various levels consider remedying present-day market intransigence through market intervention. This is a major challenge in terms of balancing fairness and effectiveness (Chandra-Putra and Andrews 2019) and one that tends to go against the grain in terms of local governments typically seeking to stimulate short-term growth and expansion of the tax base rather than the opposite. The goal would have to be to induce a sufficient and steady long-term market response to SLR exposure risk, and this means gradual price discounts in the most exposed market segments. Nonprimary homeowners across the United States already face fiscal disincentives by the way of denial of homestead exemptions in property taxes, but our findings suggest that these are too marginal to affect market behaviors where they are most needed, on the waterfront in the most expensive market segments. Sooner rather than later, fiscal disincentives may be necessary to discourage home purchases in high-risk areas along the waterfront. Such fiscal measures could be specifically targeted at nonprimary homeowners. ■

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Notes

[1] Bernstein, Gustafson, and Lewis (2019) define non-owner occupancy as the buyer not being registered at the property after the sale; their data are from the real estate assessor and transaction data sets in the Zillow Transaction and Assessment Dataset. Their usage of the term "non-owner occupiers" can be confusing because they mean to refer to the *buyers* of subsequently non-owner-occupied properties, not the occupiers who are typically renters. Our definition of nonprimary homeownership pertains to purchases by nonprimary homeowners. In our data, we cannot tell whether these buyers subsequently occupy the home or not. Clearly, some second home buyers make the purchase as an investment and do not live there; if so, and in case they rent out the property, it would be non-owner occupied (cf. Bernstein, Gustafson, and Lewis 2019), and there is likely to be some overlap among these categories. However, because our analysis is confined to single-family homes (and less likely to involve large multi-property investors that operate in the rental market), we assume that most nonprimary home buyers in our database do occupy the property, though typically only part of the time.

[2] Palm and Bolson (2020) provide compelling evidence that there is little change in perceptions about climate change among residents in coastal areas in the United States. Our research data pertain to property sales and this is, of course, a distinctly different population of sellers and buyers (the latter often coming from elsewhere). We would suggest that residents of coastal real estate who are not selling are more likely to play down or deny notions of climate change or sea level rise, if only to protect their home value. An actual sale makes for a different occasion: it involves possibly a seller who is cognizant of increased risk and a buyer seeking to leverage notions of exposure risk to lower the price.

[3] Unlike studies on the impact of flood zones (or flood insurance) on home prices, we exclude properties located in interior flood zones, along inland waterways and other bodies of water, with generally different market segments than along the coast and where we expect risk perceptions of sea level rise to be less.

[4] Tests for model misspecifications found no violations. Various coastal distance bands were also tested, and the findings were generally consistent. Besides the key independent control variables, the dummy variables of month/year of the sales and cities where sales occurred were included to account for temporal and spatial heterogeneity in sale prices. Also, we created ten spatial distance matrices with different distance bands (from 100 ft to 1,000 ft in 100-ft increments) and found that the parameters of the variables were generally insensitive to the changes of the spatial weight matrix. Finally, a 5,000-ft distance band was employed to create the spatial weight matrix for both counties because it led to the best fit of the models.

[5] Location in a flood zone corresponds to a price markup of 5 percent in Pinellas and a price discount of 3 percent in Miami–Dade. In theory, properties in flood zones would be expected to show a price discount, but existing research does not always bear that out (e.g., Lamond, Proverbs, and Antwi 2005; Bin and Kruse 2006; McKenzie and Levendis 2010; Posey and Rogers 2010; Indaco, Ortega, and Taspinar 2018).

[6] At the same time, our findings appear to differ from some studies on the impact of flood plain locations. Indaco, Ortega, and Taspinar (2018) find *no* significant price discounts for properties located in flood plains in Miami–Dade County. But they include, as do most flood plain studies, interior flood zones, whereas we focus exclusively on the 5,000-ft coastal band. We took this approach because the coastal and interior zones represent very different real estate market price segments and because we surmise that risk perceptions related to sea level rise also stronger in the coastal band than in the interior. Hence, we do not contest the findings of Indaco, Ortega, and Taspinar (2018); after all, their research question is on the effects of flood zone locations that extend well beyond our coastal band. But if the question is about the impact of *sea level rise* risk exposure, we think our particular geographic focus is more valid.

[7] It may be that in our samples Pinellas has a larger share of non-owner occupants than Miami–Dade; that is, NPHOs as investors who rent out the property (our data set does not have that information). It seems a plausible, if partial, explanation, given that the Pinellas market segments are more suitable to a broad renter market than the much more expensive segments in Miami. A comparison of overall owner occupancy rates in selected municipalities with predominantly single-family homes (our analysis focuses solely on single-family homes) does seem to bear this out: in Pinellas, the waterfront municipalities of Madeira Beach and Belleair Bluffs have owner occupancy rates of 66 percent and 67 percent, respectively; in Miami–Dade, this compares to 85 percent and 93 percent in the waterfront municipalities of Palmetto Bay and Golden Beach.

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