Disaster on the Horizon: The Price Effect of Sea Level Rise *

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Abstract

Homes exposed to sea level rise (SLR) sell at a 7% discount relative to observably equivalent unexposed properties equidistant from the beach. This discount has grown over time and is driven by sophisticated buyers and communities worried about global warming. Consistent with causal identification of long horizon SLR costs, (1) we find no relation between SLR exposure and rental rates, (2) despite decreased remodeling among exposed homeowners, current SLR discounts are not caused by differential investment, (3) results hold controlling for flooded properties and views. Overall, we provide the first evidence on the price of SLR risk and its determinants. These findings contribute to the mixed literature on how investors price long-run risky cash flows and have implications for optimal climate change policy.

JEL Classifications: G1, G14 and Q54

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1 Introduction

The manner in which investors perceive and discount long-run risky cash flows and disasters is central to a wide range of public policy debates (see e.g. Stern (2006), Nordhaus (2007), Barro (2015), and Gollier (2016)) and to understanding how investors price financial assets (see e.g. Bansal and Yaron (2004), Hansen et al. (2008), and Barro (2006)). Yet, evidence is mixed as to whether market participants correctly anticipate and price long horizon shocks. In particular Hong et al. (2016) shows that, despite the predictable nature of worsening droughts at the country level, equity markets do not anticipate the cash flow effects for agricultural firms until after they materialize. By contrast, Giglio et al. (2014) and Giglio et al. (2015), provide evidence that, when facing certain and complete loss in the form of lease expiration, marginal buyers demand a significant discount. However, this setting lacks critical features of most types of cash flow: uncertainty and heterogeneity of investor information. In cases where costs in the distant future are uncertain and complex, behavioral biases and bounded rationality appear to affect household's financial decisions (Bernheim et al., 2001).[1] Moreover, Bunten and Kahn (2014) and Bakkensen and Barrage (2017) show that heterogeneity in beliefs about uncertain and long term losses due to sea level rise (SLR) leads to believers selling to non-believers, potentially negating the house price discount via a selection effect of the marginal buyer.

We leverage the unique setting of SLR and coastal real estate to provide new evidence on how investors price imperfectly predictable long-run disasters. The scientific community shares a consensus that SLR is a serious risk, but the magnitude and timing of SLR are uncertain: for example the highly publicized 2013 IPCC (Stocker et al., 2013) report contains worst case predictions from a number of external researchers ranging from less than one meter of global average sea level rise over the century to more than two.[2] To put these projections in perspective, Hauer et al. (2016) find that a 1.8 meter SLR would inundate areas currently home to 6 million Americans and work by Zillow (Rao, 2017) suggest nearly one trillion dollars of coastal residential real estate is at risk. This risk is heavily concentrated, leading to potentially disastrous outcomes for exposed communities.[3] The durability of real estate investments, combined with the fact that real estate is by far the largest asset for the median U.S. household (Campbell, 2006), should make these predicted effects of SLR a first-order concern for millions of Americans. Markets can play a key role in mitigating this disaster: accurate pricing of SLR risk reduces the possibility of wealth transfers between uninformed and sophisticated agents, and reduces potential for future extreme price swings therefore minimizing an adverse volatility shock. Yet, as we discuss above, the long-run uncertain nature

[1] In Giglio et al. (2014) and Giglio et al. (2015) there is no uncertainty about the loss event, since there can be no debate or question that all future housing consumption is lost after lease expiration.

[2] Official estimates of SLR have been increasing over time. In January 2017, the NOAA raised its upper-bound SLR projection for the year 2100 from 2 meters to 2.5 meters. In addition, a number of communities are already experiencing the effects of SLR: according to a July 12, 2017 National Geographic article, 90 U.S. coastal communities currently suffer from chronic flooding (i.e., unmanageable flooding that causes people to move away) with this figure expected to double within 20 years.

[3] While FEMA provides subsidized insurance in flood zones, premiums are not fixed and, for individual homeowners can increase up to 18% per year according to 2015 guidelines. Thus these contracts cannot effectively insure against long run SLR risk.

of SLR risk makes its pricing an unanswered empirical question.

Our first contribution is to show that properties exposed to projected SLR sell at around a 7% discount relative to otherwise similar properties (e.g. same zip, time, distance to coast, elevation, bedrooms, property and owner type), which we show implies very similar time frames for rising sea levels as the medium to highly pessimistic scientific forecasts. This effect is primarily driven by properties unlikely to be inundated for over half a century, suggesting that it is driven by investors pricing long horizon concerns about SLR costs. Moreover, the same discount does not exist in rental rates, indicating that this discount is due to expectations of future damage, not current property quality. Second, we show that the effect of SLR on property prices is greatest in markets that we expect will treat real estate purchases as financial transactions (i.e., non-owner occupied properties), despite being likely to be rental properties where rates are unaffected. Third, we find that community beliefs regarding expected SLR risk affect the pricing of SLR, but only when transactions are less financial in nature (i.e., owner occupied properties). Finally, we show that the SLR exposure discount has increased substantially over the past decade, coinciding with both increased awareness and more pessimistic prognoses about the extent and speed of rising oceans. In particular, we document increased transaction volume and lower prices for sophisticated buyers following the significant revisions of the IPCC's 2013 release, which increased SLR projects and awareness.

To analyze the impact of SLR risk on real estate prices we combine the Zillow Transaction and Assessment Dataset (ZTRAX) with the National Oceanic and Atmospheric Administration's (NOAA's) SLR calculator to identify each property's exposure to SLR. In addition ZTRAX supplies pertinent information about the buyer, seller and property type, which we join with information on a property's elevation and distance from the coast. Our main test sample contains over 480,000 sales of residential properties within 0.25 miles of the coast between 2007 and 2016. In our baseline analyses, we define any property that would be inundated at highest high tide with a 6 foot global average SLR to be exposed.

Identifying the price effect of SLR risk requires overcoming a number of obstacles, the most prominent of which is that exposure probability decreases with distance to coast. Properties closer to the coast may be inherently different than those farther away. Our main method to address this identification issue is to compare otherwise observably equivalent properties where the variation between properties is isolated to exposure to sea level rise. In our workhorse specification we compare exposed and unexposed homes with the same characteristics (e.g. beds, property type, owner type) sold in the same month, within the same zip code, in the same 200 foot band of distance to coast, and in the same 2 meter elevation bucket.

Across a variety of specifications we find that SLR exposed properties trade at a 7% to 8% discount relative to comparable unexposed properties. We further break this into exposure buckets, with properties that will experience ocean encroachment after 1 foot of global average sea level rise trading at a 22%, 2-3 feet at a 17% discount, 4-5 feet at a 9% discount and 6 feet at a 6% discount.[4] Using the long run discount rate provided by Giglio et al. (2014) and assuming complete loss at the onset of inundation, we estimate that markets expect 1 foot of sea level rise within 35 years, 2-3 feet within 45 years, 4-5 feet after 65 years, and 6 feet in 80 years. These results are consistent with the medium to high projections provided in Parris et al. (2012) and utilized by the NOAA in their 2012 report. In addition to being robust to the inclusion of controls for a wide range of observable property characteristics, this magnitude is not sensitive to the exclusion of areas with recent flood incidents or properties said to have attractive features such as waterfront views. Owners of exposed properties are less likely to remodel their homes in recent periods consistent with work by Bunten and Kahn (2017), however this differential investment does not drive our observed discount. Moreover, placebo tests using rental properties reveal no relation between SLR exposure rental prices. Taken together, this evidence suggests that SLR exposure causes a decline in the price of coastal real estate, which is consistent with real estate buyers pricing SLR risk.

Piazzesi et al. (2015) argues that segmented search leads to price differentials across different markets: an effect especially prevalent in real estate. This insight is particularly important to the setting of SLR where the pricing of SLR risk may depend on market or investor characteristics. In particular, if the negative relation between SLR exposure and real estate prices is a manifestation of market participants attempting to accurately reflect SLR risk, then we expect the relation to be more pronounced in real estate markets in which a high percentage of transactions are purely (sophisticated) financial decisions. We empirically proxy for such a market by partitioning the sample based on whether the property is owner occupied, since purchases of non-owner occupied properties are more likely to be purely financial investments. We find that the negative relation between SLR exposure and real estate prices is concentrated in the non-owner occupied segment of the market. On average, exposed non-owner occupied properties trade at a 10% to 11% discount, relative to comparable non-exposed properties.

To provide additional circumstantial evidence on the rationality of the discount applied exposed properties, we merge our data with a county-level measure of climate change beliefs, which we obtain from the Yale Climate Opinion Maps. We find no evidence that the SLR exposure discount applied to non-owner occupied properties is related to local residents' beliefs regarding future climate change. However, we do find that such beliefs significantly affect the manner in which SLR exposure is priced in the owner occupied segment of the market. For example, in areas in the 90th percentile of climate change worry owner exposed owner occupied properties sell at a 10% discount, which is the average discount of non-owner occupied properties.

In our final set of tests we examine how new information regarding SLR expectations affects the market for SLR exposed properties. As we discuss above, expectations regarding future SLR have steadily increased over the course of our sample period. Thus, the extent that the negative relation between SLR and coastal real estate prices

[4] The majority of our properties are effected at the 5 and 6 foot level, tilting our unconditional exposure coefficient toward the smaller magnitude coefficients.

represents rational investors pricing the expected effects of future SLR. We find evidence of exactly such pricing behavior, both over the full sample and within the non-owner occupied segment of the market. At the beginning of our sample in 2007 we find no significant difference between the prices of exposed and unexposed properties. By the end of our sample in 2016, exposed non-owner occupied properties are priced approximately 13.5% below comparable unexposed properties.

We expand upon this result by conducting a difference-in-differences analysis comparing the transactions of SLR exposed and unexposed properties surrounding an event that changed expectations about future SLR. In 2013, the IPCC released an updated report on climate change that approximately doubled projected SLR over the next century. The most informative portions of that report were released in late March and April of 2014 and were accompanied by increased interest in SLR (as measured by a substantial increase in Google search intensity). After restricting the sample to periods after 2010, we find evidence that the discount applied to non-owner occupied properties increased from 8.1% to 14.0% following the IPCC release.

This event study framework also allows us examine transaction volumes surrounding an influx of new information. Again, the model in Bakkensen and Barrage (2017) as well as work on the relation between beliefs and trading by Frankel and Froot (1990), Shalen (1993), and Buraschi and Jiltsov (2006) provide some guidance: as beliefs, and in particular the extent of heterogeneity about future SLR, changes in response to these reports, we should see an increased volume of believers buying from non-believers. Our results line up with their model in two ways. First, consistent with the idea that as information about SLR risks comes to light, exposed properties should be more likely to transact, we find that the annual probability of turnover is approximately 0.2 percentage points higher for exposed properties between 2011 and 2016 (relative to a base transaction rate of approximately 11% for all properties). This is entirely driven by the period following the IPCC report where we see a 0.8 percentage point increase in the annual probability of an exposed property transacting.

Current finance literature provides little evidence that uncertain but predictable long horizon cash flow shocks are priced by market participants. While Giglio et al. (2014) show a 2.6% discount at the 100 year horizon for freehold vs leased real estate, confirmed by follow-up work by Fesselmeyer et al. (2017) and Bracke et al. (2017), their results are not straightforwardly applied to many real-world settings where investors face different information sets about uncertain outcomes. We contribute to the asset pricing literature by providing evidence that, even under these conditions, SLR risk generates similarly sized discounts in real estate prices. Additionally, we show that heterogeneity in both investor type as well as beliefs about SLR create dramatic variation in the market price of exposed assets. Our house price discount supports low discount rates, which complement work by van Binsbergen et al. (2012), who show downward sloping equity discount rates.

Our paper also provides new evidence on the pricing of coastal properties. Many papers examine the trade-off between imminent flood risks and the amenities associated with coastal living. In particular Atreya and Czajkowski

(2014) argue that amenities outweigh flood risk, while Ortega and Taspinar (2016) argue that extant damage and the perception of future flooding result in significantly lower house prices in the greater New York area. Importantly, our paper focuses on much longer horizon effects and eliminates the contribution coming from either recent flood risk or current amenities, but still finds a large pricing effect. We also build on a broad literature examining the drivers of the returns to real estate investment (see e.g. Lustig and Van Nieuwerburgh (2005), Piazzesi et al. (2007)).

Finally, our research builds on the macro-finance literature on household balance sheets and optimal household decisions. Campbell (2006) documents that housing wealth provides the plurality of retirement savings and our work helps to understand the extent to which homeowners identify SLR risk and adjust prices in response. In doing so, we contribute to the literature documenting sub-optimal household decision making across a variety of dimensions often stemming from inattention (see e.g. Andersen et al. (2015); Chetty et al. (2014); Huberman et al. (2007); Stango and Zinman (2009)). We document similar lack of attention to SLR risk among unsophisticated investors, particularly when those investors are not worried about climate change. This is provides one example of case in which optimistic investors can drive asset prices as in Piazzesi and Schneider (2009).

Finally, we contribute to the literature exploring the potential costs of climate change and value of current interventions. Deschênes and Greenstone (2007) provide evidence that weather changes due to climate change are likely to have significant negative effects for the value of agricultural land. We complement this finding by showing that concerns about climate change among coastal properties already is affecting real estate value. We also build on a broad set of papers trying to understand the present value cost of climate change and the benefit of mitigation strategies (see e.g. Stern (2006); Nordhaus (2007); Becker et al. (2011); Deshpande and Greenstone (2011); Weitzman (2012); Nakamura et al. (2013); Barro (2015); Gollier (2016)). The significant SLR price discounts are consistent with the potential for significant gross benefits of mitigation strategies which can reduce future costs of climate change. In fact, our finding that remodeling has fallen among exposed properties suggests, just as has theoretically shown by Bunten and Kahn (2017), that households are already altering their investment strategies in the face of concerns about the future costs of climate change since they find it optimal to dis-invest as a loss mitigation strategy. By contrast, our observed price discounts are lowest among less sophisticated buyers, where housing constitutes the plurality of their savings (Campbell, 2006), and regions that don't believe in climate change. The absence of a current house price discount raises the possibility of a large wealth shock to coastal communities unless strategies are undertaken to mitigate the effects of SLR.

2 Data

2.1 Main Sample

We obtain property-level data from the real estate assessor and transaction data from the Zillow Transaction and Assessment Dataset (ZTRAX). ZTRAX is, to the best of our knowledge, the largest national real estate database of its kind with information for more than 374 million detailed public records across 2,750 U.S. counties over more than two decades. It also includes detailed assessor data including property characteristics, geographic information, and valuations on over 200 million parcels in over 3,100 counties.

Characteristics from the assessor files provide exact geo-coded locations of each property, which allows us to determine the property's distance from the nearest coastline point as well as its elevation. The dataset also contains information on the existence of a sea or ocean view, a property's flood zone status, and a broad set of property information including square footage, number of bedrooms/bathrooms, pool, garage size, and build year. Importantly, we also see the type of property (e.g. single family residence, condo, town-home) as well as detailed information on the buyer and seller of the property. In particular, Zillow encodes whether or not the unit is owner-occupied following the sale, the type of buyer, and the address of the buyer and seller.

We filter the Zillow data in 3 ways. First, we retain only transactions of residential properties for which the price of the transaction is verified as being between $50,000 and $10,000,000. Second, we only include transactions that occur within a quarter mile of the beach. Finally, we only include properties with sufficient non-missing property information. This leaves us with a total of 481,321transactions.

To implement our research design, we determine the property-level exposure to SLR for all properties within our sample. Since tidal variation and other coastal geographic factors affect the impact of global oceanic volume increases on local SLR, we utilize the NOAA's SLR calculator to define each property's exposure to SLR. As exhibited in Figure 1, the NOAA provides detailed SLR shapefiles that describe the latitude and longitudes that will be inundated following a 1-6 foot increase in average global ocean level.

We utilize geographic mapping software to assess the exposure level of each property within a coastal county in the Zillow data. We find that approximately 1.7 million homes within the assessor file are exposed to SLR of between 0 and 6 feet. Of this larger sample, we filter only homes that are within 0.25 miles of the beach and for which we observe a Zillow transaction as stated above, dropping our sample of exposed transactions to 144,880. Thus, approximately 30% of properties in our test sample are exposed to a 6-foot rise in sea levels. Figure 2 provides a county by county map of the proportion of tansactions that involve exposed properties in each county throughout our sample period, which is constructed using all properties within a county rather than only those within 0.25 miles of the coast. We can see from this map that the hardest hit counties are in the gulf region, Washington state and, to a lesser extent, long the eastern seaboard.

Panel a of Table 1 provides summary statistics for the transactions in our main sample. In general, exposed and unexposed properties are economically similar. They are very similar in terms of square footage and property age, but exposed properties sell for $670 per square foot on average, which is more than a 10% premium over unexposed properties. A likely driver for this premium is that exposed properties are typically closer to the coast. Throughout our empirical analysis we aggressively control for any observable differences between exposed and unexposed properties. In particular, we include miles-to-coast and elevation bin fixed effects to ensure that we do not misattribute any price differences between exposed and unexposed properties.

2.2 Supplemental Data

2.2.1 Rental Prices

As we discuss below, we replicate our analyses using rental market information. To do so, we collect rental data from Trulia utilizing a python based web scraper. On November 6th 2017, we queried Trulia for rental properties in each zip code appearing in our sample with at least one exposed property. The site returns (in JSON format) pages containing 35 properties with detailed information including address, price, square footage, geo-data, number of beds and number of baths. Exactly as with the Zillow data, we identify the SLR exposure status as well as the elevation and distance to coast.

Figure 3 demonstrates the quality of the rental listing data scrapped from Trulia.com. Panel a is a scatter plot of the relation between median log(rental list price) scraped for individual properties from Trulia.com with the log(rental list price) for aggregate data publicly available by zip code from Zillow.com for November of 2017. These measures of rental rates from independent sources are very similar with a correlation of 94.8% at the zip code level. Panel b is a scatter plot of the relation between median log(rental list price) scraped on November 2017 for individual properties from Trulia.com with the log(median house price) for all property-level transactions from the proprietary ZTRAX database from 2007-2016 at the zip code level. Again, the relation between these variables is strongly positive (with a corrleation of 84.1%), suggesting that the data are of high quality. Panel b of Table 1 shows that exposed and unexposed rental properties are observably similar, as in our Zillow sample. On average, both exposed and unexposed properties rent for approximately $6,000 per month[5], are approximately 1,500 square feet, and have 2.25 bedrooms.

2.2.2 Climate Change Beliefs

Finally, we merge our data with the Yale Climate Opinions map data (Howe et al., 2015). This service provides survey data at the county level regarding perceptions of climate change. In the words of researchers behind the

[5] While this may seem high it is worth noting that these are already restricted to properties within a quarter mile of the beach which tend to be highly desirable.

project,

> The model uses the large quantity of national survey data that we have collected over the years — over 13,000 individual survey responses since 2008 — to estimate differences in opinion between geographic and demographic groupings. As a result, we are able to provide high-resolution estimates of public climate change understanding, risk perceptions, and policy support in all 50 states, 435 Congressional districts, and 3,000+ counties across the United States. We validated the model estimates with a variety of techniques, including independent state and city-level surveys.

In particular we utilize the county level survey data capturing whether the respondents are "worried about global warming." Importantly, we see significant variation in this measure. Moreover, it is negatively correlated with the county-level exposure percentage. While this may be driven by external factors, this negative and significant correlation between worried and exposed is consistent with the model proposed in Bakkensen and Barrage (2017), in which less worried individuals move away from exposed areas.

3 Empirical Predictions and Methods

3.1 Main Specification

To the extent that participants in the real estate market foresee and discount the potential losses associated with SLR, this should be directly apparent in transaction prices. Ceterus paribus, SLR exposed properties should trade at a discount versus properties that are unlikely to be affected. The goal of our empirical design is to compare properties that transact in the same month and zip code and are observably equivalent (i.e., have the same number of bedrooms, distance to the coast line, owner occupancy status, and 6 foot elevation above sea-level), but vary in the amount of SLR that would cause them to be underwater. The resulting specification takes the following form:

$$HousePrice_{it} = \beta\, Exposure_{it} + X_{it}\phi + \lambda_{ztmeopb} + \epsilon_{it} \tag{1}$$

where the dependent variable $HousePrice_{it}$ is a measure of the housing transaction price for property i, in month t. $Exposure_{it}$, our explanatory variable of interest, is a dummy variable equal to 1 if 6 feet or less of SLR would put the property underwater. X_{it} includes 4th order polynomials of building square footage, property age, and miles-to-the coast. The key to our identification strategy is $\lambda_{ztmeopb}$, which absorbs variation in house price that is related to the interaction between location, time of sale, and property characteristics, including the distance a property is from the coast and the property's elevation above sea level. Specifically, $\lambda_{ztmeopb}$ is comprised of interacted fixed effects between: zip code z, year x month t, miles-to-coast category m[6], 6 foot elevation buckets e, owner occupancy indicator o, condominium indicator p, and total bedrooms b. After including this full set of fixed effect interactions, our assertion is that the remaining variation in exposure to SLR is as if randomly assigned and thus a plausible basis for causal interpretation of, β - the effect of SLR exposure on house prices.

Although the inclusion of fixed effects for region x time x property characteristics is fairly ubiquitous in the housing valuation literature (see e.g., Giglio et al. (2014)), the inclusion of an interaction with categorical dummies for miles to the coastline, which are only approximately 220 feet in size on average, but increase in width farther from the beach, are less common and critical for our identification strategy. Not only does their interacton with zip code improve the granularity of our location control, but they control for ease of beach access. In figure 4 Panel a we plot the non-linear relationship between distance to the coast line and the log of house price per square foot, while in Panel b we plot that same relationship, but after controlling for zip code x time fixed effects. In both cases, we show that as properties get closer to the coast line the value of the property quickly increases. These results should not be surprising since these properties have both improved amenities, such as beach access, (see e.g., Atreya and Czajkowski (2014)) and more SLR exposure. Thus, distance to the coast fixed effect interactions are necessary in all specifications intended to identify the causal effect of SLR on home prices.

3.2 Robustness Analyses

Even in the presence of this research design, it is still possible that there exist amenities or dis-amenities that jointly correlate with SLR exposure and drive house prices which would compromise our ability to identify the causal effect of SLR. One possibility is that properties with high SLR exposure could be have been recently flooded, causing damage and reducing house value. While this would be suggestive a relation between house prices and SLR, it would not reflect the long-horizon disaster risk we are trying to disentangle. A second plausible concern could be that higher properties have better views, increasing their value relative to lower-lying properties. Finally, SLR exposure could affect house value by changing the value of remodeling or investing in these properties. While concerns about SLR exposure are likely to alter current long-term investments in the property, if those are driving the house price effects we observe we can't cleanly separate out changes in value driven by concerns about future SLR losses from those driven by reduced improvements.

As we discuss in more detail in the following section, we take several steps to mitigate these concerns. First, we interact all other fixed effects with 6 foot elevation above sea level buckets. Although a 6 foot range is unlikely to yield substantially differences in amenities such as views or current level of flooding, it would still lead to substantial differences in future SLR exposure. Second, we rerun all analysis showing results excluding (1) regions that have

[6] There are seven miles-to-cost bins, corresponding to the following miles-to coast cutoffs: 0.01, 0.02, 0.04, 0.08, and 0.16. The average bucket size is 220 feet wide.

recently flooded, (2) properties listed as having nice views, or (3) properties in the top 10th percentile of elevation of properties in the same zip code that are the same distance or closer to the coast. Third, we examine whether SLR exposed properties differ on observable co-variates that are not part of their choice function, such as original property age and/or lot square foot size, to provide comfort that co-variates are unlikely to be driving observed outcomes.

We also re-run the analysis in equation 1, but with either (1) the probability of being re-modeled as the dependent variable or (2) excluding all re-modeled properties. This lets us ascertain both the extent to which SLR exposure affects investment in a property and how much of any observed price discount could be affected by any change in investment. Finally, we re-run our primary methodology using rental listing prices, instead of sale prices. Non-causal interpretations of our estimated relation between SLR costs and house prices would predict a similar effect using rental data. By contrast, if the relation between long horizon SLR costs and house prices is causal we expect there to be no significant relation between SLR exposure and rental rates, since rental prices embed only short-term features of living in the property. To address concerns that these results could be driven by heterogeneous effects and differences in type between rental and owner occupied dwellings we also re-run our analysis among only condos and properties that are not owner occupied, since those are also typically rental units.

3.3 Exploring Heterogeneity

In addition to serving as a robustness check on our main findings, the examination of differences between treatment effects by owner vs. non-owner occupied residencies leads into a natural exploration of what factors, such as beliefs, sophistication, and expert reports, alter the size of the effect of SLR on house price discounts. Since non-owner occupied properties are purchased primarily for investment income we believe these investors are more likely to be sophisticated in their purchase decision, making SLR exposure a larger consideration. These buyers are less likely to driven by non-pecuniary concerns, such as proximity to work or family, which could constrain efficient search and pricing. In addition to looking at heterogeneity in treatment driven by owner occupancy, we also examine the extent to which community beliefs affect the price discount. If community beliefs regarding global warming affect the pricing of SLR risk, then we expect the effect to be largest in markets with fewer sophisticated buyers.

In our final set of tests we examine how new information regarding SLR expectations affects the market for SLR exposed properties. Over the course of our sample period expectations regarding future SLR have steadily increased. Perhaps the most comprehensive SLR projections are released periodically by the Intergovernmental Panel on Climate Change (IPCC). In their 2007 report, the IPCC projected that sea level would rise by only 0.18 to 0.59 meters by the end of the century,[7] but in 2013, the IPCC updated its own projections, approximately

[7]Other sources released between 2007 and 2009 projected higher SLR (see e.g., Pfeffer et al. (2008)) however there is substantial variation in the projections across studies.

doubling SLR expectations. More recently, in January 2017, the NOAA raised its upper-bound SLR projection for the year 2100 from 2 meters to 2.5 meters. To the extent that the negative relation between SLR and coastal real estate prices represents rational investors pricing the expected effects of future SLR, we expect the negative relation to be increasing over time, along with projected SLR. Notably, alternative explanations for the relation between SLR exposure and house prices would not make such a prediction. For instance, since short-horizon flood risk projections have not increased over our sample period so we would not expect the SLR discount to change to the extent that it is driven by the risk of flooding in the near future.

To better identify how new information regarding SLR expectations affects the coastal real estate markets, we next hone in on specifically on the time around the release of the 2013 IPCC report, which we argue represents the single biggest shock to SLR expectations. The most informative portions of that report were released in late March and April of 2014. Figure 5 displays the Google search intensity for the term "sea level rise" from 2004-2017 and provides supporting evidence that the 2013 IPCC report was publicly known.[8] During the entire time series from 2004-2017, May of 2014 represents the maximum search intensity for SLR. Thus, the most significant revision in expectations of SLR over the last 15 years was accompanied by the largest measurable increase in awareness of the topic, making the 2013 IPCC report a promising event around which to structure our tests. We re-run the analysis 1, but focus on how transaction volume and house prices change in the period surrounding the announcement. If the announcement of the report alters beliefs about SLR risk we would expect increased transaction volume among exposed properties and consistent with an overall increase in the price discount over time we would expect exposed property values to decline.

4 Results

4.1 Effect of SLR Exposure on Coastal Real Estate Prices

Evidence from the scientific community suggests that SLR will become a first-order concern for millions of Americans over the next century (see e.g., Hauer et al. (2016)). The durability of real estate investments, combined with the fact that real estate is by far the largest asset for the median U.S. household (Campbell (2006)), should lead investors to discount properties in accordance with their SLR exposure. However, the extent to which investors actually perform such discounting remains an unanswered empirical question. Moreover, the literature examining how investors price long-run and disaster risks generates competing predictions as to whether such discounting will occur.

On the one hand, the financial markets do not always accurately price predictable long-run risks (see e.g.,

[8]Around this time, articles detailing the increased fragility of the Thwaites glacier Joughin et al. (2014) also received significant attention likely adding to the increased search activity.

Hong et al. (2016)). This seemingly irrational investment behavior is even more striking when considering personal finance decisions, such as retirement saving (see e.g., Chetty et al. (2014)). Piazzesi and Schneider (2009) show that such behavioral biases (in the form of investor beliefs) can affect real estate market prices, especially when real estate prices are set via bilateral negotiations (as opposed to an established market price). On the other hand, there is evidence that market prices do reflect long-run and disaster risks at times (see e.g. Bansal and Yaron (2004), Hansen et al. (2008), and Barro (2006)). Furthermore, Giglio et al. (2014) finds that very long-run cash flows are an important driver of real estate value as investors discount fairly certain cash flows arriving in 100 years at an annual rate of only 2.6%. This evidence coupled with the fact that real estate prices often reflect flood risks (see e.g., Bin and Landry (2013)), raises the possibility that expected future SLR materially affects the prices of exposed real estate.

In Table 2 we present baseline regression results that provide the first evidence on this empirical question. In Column 1, we regress the natural log of sale price on an indicator for SLR exposure and zip code x year-month x miles-to-coast x total bedroom bucket fixed effects. The SLR Exposed coefficient of -0.08 suggests that exposed properties sell for 8% lower prices relative to unexposed properties sold in the zip code during same month that are a similar distance from the beach and have the same number of bedrooms. Column 2 provides a similar specification, except normalizes our price variable by property square footage thereby eliminating any concern that exposed properties are simply smaller than unexposed ones. Although this negative relation between SLR exposure and coastal real estate prices is consistent with market participants pricing long-run SLR risks, there are several potential alternative explanations.[9]

In Column 3, we begin to address one such alternative, which is that the SLR exposed properties sold during our sample period are different from unexposed properties, even after aggressively controlling for the distance from the coast. After adding fourth order polynomial controls for property age, square feet, and miles from the coast, we continue to find a significant negative relation between SLR exposure and sale price. The similarity between the estimates in Column 1 and those in Columns 2 and 3 suggests that the negative relation between SLR exposure and coastal real estate prices is not related to differences in the age or size of exposed and unexposed properties.

In Column 4, we expand our fixed effects to control for several additional property and deal characteristics. Specifically, we interact our zip code x year-month x miles-to-coast bucket fixed effects with fixed effects for the number of bedrooms x six-foot elevation bins x condominiums x owner occupancy x local buyers. Not only does this fixed effect structure more aggressively control for property characteristics, but it also ensures that significant differences in elevation do not drive the observed relation between SLR exposure and sale prices. For example,

[9]Observation counts differ with the summary statistics because singleton observations are removed from the analysis. Given the broad set of fixed effects used in our empirical methodology this distinction causes substantive changes in the observations available for estimation. In the spirit of full transparency we report the observation counts absent these singleton observations, rather than the raw observation count of all data analyzed.

although properties within a 6-foot elevation bin may have significantly different SLR exposure, they are unlikely to have materially different views.[10] The SLR Exposed coefficient of -0.078 in Column 4 suggests a significant negative relation between SLR exposure and coastal real estate prices. The persistence of the estimated relation between SLR exposure and coastal real estate prices across these various specifications makes it unlikely that this relation is due to differences between exposed and unexposed properties that are unrelated to SLR. Finally, in Column 5 we include an additional regression where we leave out fixed effects and find exactly the result stated in Atreya and Czajkowski (2014) where exposure is actually associated with higher prices, thus illustrating the importance of our identification framework.

Another potential driver of the price difference between exposed and unexposed properties is current flood risk. Bin and Landry (2013) find that flood risk is only priced when a flood has recently occurred in the area, so we begin by excluding properties in counties that have recently experienced flooding. This has the added benefit of eliminating all properties that may be less valuable due to past flood damage, which are likely to be disproportionately exposed properties. To this end, Column 1 of Table 3 excludes counties that experience flooding in the current year or have experienced flooding in the past 3 years. Similarly, Column 2 excludes all counties that have received FEMA assistance through the individuals and households program (this is triggered when homes are damaged in FEMA flood zones and dates to 2000). Neither of these sample restrictions, which reduce our sample by approximately 30% and 60% respectively, eliminate the significant negative relation between SLR exposure and sale prices. Moreover, the 95% confidence interval on the estimated effect includes the -0.078 point estimate from our baseline model in Column 4 of Table 2. Thus, past flood exposure is an unlikely driver for the observed negative relation between SLR exposure and coastal real estate prices. Finally, Column 3 of Table 3 excludes all properties with a designated lot site appeal—this field has an indicator for view—and excludes any properties in the top 90% of elevation within the zip code. Again, the coefficients remain unchanged meaning the discount is unlikely to be related to view or other property features.

The stability of the relation between SLR exposure and real estate prices suggests that a causal interpretation of the SLR coefficient is reasonable. However, we cannot completely rule out the possibility that unobserved characteristics that are correlated with both SLR exposure and sale price contribute to the estimated effect. To mitigate such a possibility we next conduct a series of placebo tests. Columns 4 and 5 of Table 3 conduct the first two such tests regressing the natural log of property age and square footage on our full set of fixed effects. To the extent that our fixed effects absorb property-level information (i.e., SLR's effect on price is causal), we expect no relation between SLR exposure and property characteristics that are not directly affected by expected SLR. Consistent with this, we find no significant relation between SLR exposure and either property age or square footage. Thus, our fixed effect structure appears to absorb enough property- and deal-level information such that

[10] Throughout the paper we will utilize this full array of fixed effects as our primary specification.

there is no relation between SLR exposure and other observable property characteristics, which may be correlated with price.

Our next set of placebo tests examines the relation between rental prices and SLR exposure. These tests are predicated on the idea that both renters and buyers care about property quality, but, unlike buyers, renters do not care about long-run SLR risk. Thus, if the relation between SLR exposure and sale prices that we observe is causal, we expect no significant relation between rental prices and SLR exposure. If instead the relation between exposure and sale prices that we observe is due to omitted property characteristics, amenities, or short-run costs, then we would expect a negative relation between SLR exposure and rental prices. Table 4 presents estimates for regressions of rental prices on SLR exposure. Column 1 replicates our main specification from Table 1 (Column 4) in the rental market where we include the full spectrum of controls and fixed effects. We find no similar discount in rental rates for exposed properties. Similarly, when we exclude flooded regions in Column 2, we find no significant effect. Column 3 excludes the set of nonlinear control variables, again showing no significant results indicating that the lack of significance is not arising from over fitting of the residual data. Finally both Columns 3 and 4 show that our low T-Stats are not driven by a choice to cluster conservatively at the zip level. Here, we do not cluster, and find precise zero estimates.

To the extent that homeowners believe SLR will render their home unlivable over the long horizon, they may choose to invest less in their property. As such, one channel through which SLR risk potentially impacts prices aside from future inundation is through the reduced investment behavior of homeowners resulting in current differences in property quality. While we find little to suggest this in prior tests, in Table 5, we examine first whether exposure leads to different remodeling rates and second whether remodeling directly drives our observed price discount. Column 1 indicates that the probability of having remodeled is lower over the sample period (which starts in 2007) for exposed properties. The unconditional probability of property having remodeled since Jan 1 2007 in our sample is 1.6%, so exposed properties are approximately 20% less likely to remodel. However, as shown in column 2, there is no difference in remodel rates prior to the beginning of our sample period. This result is consistent with a narrative where information about the risks of sea level rise have become salient to homeowners only in recent periods, which we will discuss more in Section 4.2.2. Moreover, any property specific characteristics (both observable and unobservable) that have remained unchanged through the life of the property, e.g. location benefits, views, prior flood risk, cannot be driving the differential investment result for exposed properties.

Although reduced investment is likely to accrue over time and therefore result in lower quality homes in exposed areas in the future, we do not find that lower remodel rates are directly driving the observed discount. Columns 3 and 4 exclude properties that were remodeled over our sample period and prior to our sample period respectively. In both cases the coefficient on exposed is effectively unchanged from the complete specification in Table 1 column 4. One reason that excluding remodeled properties has a minimal effect on the SLR discount is the small fraction of homes that were remodeled and subsequently sold during our sample period. In the coming decades, it is possible that reduced investment among exposed properties will further increase the price difference between exposed and unexposed properties.

Taken together, the findings in Tables 2 through 5 indicate a robust negative relation between SLR exposure and coastal real estate prices. This negative relation does not appear to be driven by exposed properties having different property characteristics or having been subject to past flooding events. Placebo tests further support a causal interpretation of the effect of SLR exposure on coastal real estate prices. The magnitude of the effect is relatively persistent across the various specifications. SLR exposed properties sell at a 7% to 8% discount relative to comparable non-exposed properties. The most plausible alternative explanation for the relation between SLR and home prices that we observe is that it reflects current flood risk and not the pricing of exposure to future SLR. At least two results presented thus far make this an unlikely driver of our results. First, we find no relation between SLR and rental prices. This is consistent with renters not believing that flood risks over the life of their rental lease will significantly differ for exposed and unexposed properties. Second, excluding previously flooded areas does not significantly affect our results. Given that current and past floods predict floods in the near future, this evidence suggests that differences in immediate future flood risk do not drive our results. In our next set of tests, we further examine this issue by partitioning SLR exposure into 1-2 foot bins. To the extent that the SLR discount is present in homes with exposure to only 5 or 6 foot SLR, it is unlikely that the discount is driven by concerns relating to the immediate future.

Figure 6 illustrates the effect of SLR exposure on house prices using this more continuous measure of SLR exposure. We include all fixed effects and controls specified in equation 1, but include categorical dummies for the amount of SLR that would put the property underwater. This allows us to look at the non-linear relationship between SLR exposure and house prices. Across all interactions we see a statistically negative effect of SLR exposure, meaning that any amount of exposure is related to a price discount relative to unexposed properties (i.e., those with >6 feet SLR required to be underwater). Since properties that require more than 5 feet of SLR, but at 6 feet are underwater still see a significant reduction in price this again lends credibility to the idea that much of the estimated relation between SLR exposure and home value is due to long-horizon risk, not more immediate concerns. We also find that exposure effects are monotonically increasing as less SLR is required to put properties underwater, just as would be expected. The less SLR required to put a property underwater the more likely and imminent the expected losses and the larger the price discount we would expect. In particular, for properties imminently at risk, such as those that would be underwater with 1 foot of SLR, we find that exposure reduces those property values by 22.1%. By contrast properties that require 6 feet of SLR to become underwater experience only a 5.7% discount relative to unexposed properties.

These findings contribute to the growing literature on how investors price long-run risks (see e.g., Bansal and

Yaron (2004); Hansen et al. (2008); Giglio et al. (2014, 2015); Piazzesi et al. (2015)). Our findings that investors price long-run SLR risk is also relevant from a policy perspective because it suggests that on average investors believe that SLR will materially affect coastal economies over the coming decades.

Although determining whether this magnitude is correct is beyond the scope of this paper, it is worth noting that the estimated magnitude is plausible. By making two simplifying assumptions, we can interpret Figure 6 to assess the market expectation of the timing sea level rise risk. First, when sea levels rise to the point where a property becomes exposed, we assume the property is immediately unlivable and worthless. That is, we assume no impact on cashflows until the moment a property is under water, at which point cash flows cease. Likely, sea level rise would begin to impact a property prior to rendering it uninhabitable, meaning at least some portion of the discount we observe is attributable to reduced cash flow before the property becomes worthless. Relaxing this assumption would cloud the interpretation as to when the SLR begins to be priced.

Second, we assume that the discount rates on coastal housing properties follow those detailed in Giglio et al. (2014). In particular, we assume that the relevant discount rate for the properties in our sample is 2.6%,[11] the estimated 100 year discount rate from their study. This rate provides a conservative estimate for the market estimated timeline for ocean encroachment for two reasons. First, near term discount rates are likely higher, so a property with a 30 year lifespan should have a higher discount rate. Additionally, the rates in Giglio et al. (2014) are assessed on properties facing no unusual systematic risk but which, when the lease expires, will have an effective negative 100% cash flow event. Properties in our setting are actually likely to face risks that are correlated with a global disaster (large SLR) and as such should have a higher rate. Both cases would argue for a higher discount rate, meaning to observe the same price differential, the SLR shock would necessarily have to occur earlier.

To translate our estimates into the market expected timing of SLR risk, we start with the assumption that the value of a property is simply the discounted sum of future cash flows. For unexposed properties (u), we assume these cash flows in perpetuity, while exposed properties (e) cease providing income at some date T.

$$V_u = \sum_{s=1}^{\infty} \frac{CF_u}{(1+r)^s} = \frac{CF_u}{r} \tag{2}$$

$$V_e = \sum_{s=1}^{T} \frac{CF_e}{(1+r)^s} = \frac{CF_e}{r} - \frac{CF_e}{r(1+r)^T} \tag{3}$$

Our estimated coefficients presented in Figure 6 indicates the impact on log price of a property for being exposed at certain levels of exposure. Thus we can interpret the inverse of this coefficeint as the log ratio of prices for exposed

[11]This discount rate is also in line with a survey conducted byDrupp et al. (2015) of 197 researchers views of long run discount rates where 90% were comfortable with a range of 1% to 3%.

and unexposed homes.

$$\log\left(\frac{V_e}{V_u}\right) = \beta_e \tag{4}$$

Since our properties are observationally equivalent, and we know that from our placebo test the rental cash flows are effectively the same for exposed and unexposed properties, we set $CF_u = CF_e$. Inserting equations 2 and 3 above and rearranging yields the following expression which expresses the observed discount as a function of the T.

$$\log\left(1 - \frac{1}{(1+r)^T}\right) = \beta_e \tag{5}$$

Plugging in our point estimates from Figure 6, we observe the following market expectations for the timing of SLR impact. According to this equation, the prices of exposed homes suggest a window of 36 years before homes which will be exposed to one foot of SLR are worthless, 45 years for homes exposed with 2-3 feet of SLR, 65 years for the 4-5 foot homes and 80 years for those homes that will be exposed with 6 feet of average sea level rise. These estimates fall between the intermediate and high scenarios prepared by Parris et al (2012) for the NOAA and are generally more pessimistic than the median scenario used by IPCC indicating that the market view of SLR risk is actually slightly stronger than the consensus median scientific view.

4.2 When do Coastal Real Estate Markets Price SLR risk?

In this section, we examine heterogeneity in the relation between SLR exposure and coastal real estate prices. Our first two sets of tests address the empirical question of the types of markets that most aggressively price SLR risk. Specifically, we examine the extent to which the relation is due to the real estate markets rationally accounting for SLR exposure or whether it is affected by local individuals' beliefs regarding expected future SLR. Next, we examine examine how new information regarding expected SLR affects the market for SLR exposed properties. These tests provide evidence on the joint hypothesis that our findings are due to investors pricing SLR exposure and that investors have increased their beliefs regarding expected SLR over the course of our sample period along with the scientific community.

4.2.1 Is the SLR Exposure Discount drive by Financial Risk or SLR Beliefs?

If the effect of SLR exposure on real estate prices is a manifestation of price setters' attempt to accurately reflect SLR risk, then we expect the relation to be more pronounced in real estate markets in which a high percentage of transactions are purely (sophisticated) financial decisions. Although all buyers of a given property are exposed to the same future cash flow risks (whether they appropriately estimate these risks or not), these cash flow risks will represent a larger part of a buyer's utility when the purchase is a financial decision. Put differently, someone buying a home for non-financial reasons may extract consumer surplus because the particular property is a good fit. Unlike the expected future sale price of the home, this consumer surplus will not to be as affected by future SLR expectations.

To examine this idea we partition the sample based on whether or not a property is owner occupied, because non-owner occupied purchases are more likely to be financial investments. If investors' pricing of financial risk drives the negative relation between SLR exposure and real estate prices, then we expect the SLR exposure discount to be largest for non-owner occupied properties.

Column 1 of Table 6 regresses the natural log of sale price per square foot on an indicator for SLR exposure and its interaction with an indicator for a non-owner occupied property. The majority of the negative relation between SLR exposure and real estate prices is in the approximately 42% of properties that are non-owner occupied. The main SLR Exposed effect drops to -0.03 and is only marginally statistically significant, suggesting that SLR exposure has little effect on the price of the average owner occupied property. By contrast, the SLR Exposed x Non-Owner Occupied interaction is highly significant, with a point estimate of -0.080. Summing this interaction with the main SLR Exposed coefficient of -0.030, suggests that exposed non-owner occupied properties trade at an 11.0% discount, relative to comparable non-exposed properties.

In Columns 2 and 3 of Table 6 we introduce two additional proxies for the information set of the buyer. First, we look at out of zip code buyers as they, like non-owner occupiers, are more likely to be purchasing on an informed financial decision. Second, we examine whether condominiums—a more homogeneous real estate product for which the public price signal is likely to be more reflective of the average investor's willingness to pay—are more or less sensitive to exposure. The interactions between SLR exposure and both non-local buyers and condominium sales are negative, although the condominium interaction is statistically insignificant. Column 4 simultaneously includes all three interactions, and shows that only the Exposed x Non-Owner Occupied interaction remains statistically, and economically, significant.

The results in Table 6 suggest that SLR exposure affects the average price of SLR exposed real estate in the non-owner occupied market, but not the owner occupied market. These findings contribute to and support the literature on segmented real estate markets. In particular, Piazzesi et al. (2015) shows that segmented search markets can lead to differential pricing depending on participant characteristics. Although we cannot definitively say whether the SLR exposure discount is correct in either market segment, segments that we argue are dominated by purely financial transactions are pricing SLR exposure in a manner that is more consistent with the scientific community's projections re garding the expected effects of SLR. These results also strengthen the validity of our placebo test with rental listings. Since non-owner occupied properties are also those that are rented the fact that exposure effects are largest among these properties, suggests that the absence of an effect of exposure on rental rates is not driven by differential property types.

In our next set of tests, we examine whether community beliefs regarding expected climate change affect market prices. Piazzesi and Schneider (2009) show that such an effect is possible and most likely when prices are set via bilateral negotiation, which we posit is more likely in the owner occupied market segment as is does not appear to have a market price that incorporates SLR risk. If prices in the owner occupied housing market are indeed driven by the opinions of investors, then we expect the community's beliefs about the effects of climate change to affect the relation between SLR exposure and real estate prices. In contrast, we expect no such relation in the non-owner occupied market, to the extent that properties are priced based on the market's expectations regarding expected future cash flows. To empirically investigate this idea, we merge our data with the Yale Climate Opinion Maps, which provides an aggregate measures of a residents' answer to the question "Are you worried about climate change?."

In Table 7, we regress property sale prices on SLR Exposed and its interaction with Worried. Column 1 shows that a county's reported level of concern over future SLR does not significantly affect the average effect of SLR on exposed real estate prices. In Column 2, which restricts the sample to non-owner occupied properties, we continue to find a negative relation between SLR exposure and a property's price, but no evidence that this relation is sensitive to an area's beliefs. This is consistent with the non-owner occupied property market establishing a price that incorporates SLR risk.

Column 3 shows that beliefs play a significant role in the pricing of owner occupied coastal properties. Although the prices of owner occupied properties are not significantly related to SLR exposure on average, SLR exposure does affect prices when an area is sufficiently worried about SLR. For example, at the 90th percentile of Worried, which corresponds to a Worried z score of 1.36, exposed owner-occupied properties sell at a 10% (1.36*0.053+0.028) discount. This is comparable to the average discount of non-owner-occupied properties.

Taken together, the results in Tables 6 and 7 suggest that the effect of SLR exposure on coastal real estate prices critically depends on the market structure. The market for non-owner-occupied properties consistently prices SLR risk in a seemingly rational manner. In contrast, the market for owner-occupied properties only prices SLR risk to the extent that area residents are worried about SLR. These findings are consistent with non-owner occupied property purchases being based more directly on the market's expectations regarding expected future cash flows, as opposed to bilateral negotiations dictated in part by personal preferences and beliefs.

4.2.2 Does new information about expected SLR affect exposed properties?

As we have noted, over time the IPCC has steadily increased their SLR projections. Thus, if the negative relation between SLR and home prices represents long-run SLR exposure, then it should become increasing large over time. In Table 8, we empirically examine this by regressing sale price per square foot on SLR Exposed and its interaction with the natural log of months since the beginning of our sample. The statistically insignificant SLR Exposed coefficient in Column 1 suggests that SLR exposure had little effect on coastal real estate prices at the beginning of our sample in 2007. Rather, the significantly negative Exposed x Time interaction suggests that the negative relation between SLR exposure and prices has emerged throughout our sample period. Given that the logged time trend maxes out at 4.79 at the end of our sample period, the coefficient of -0.02 suggests that by the end of 2016 exposed properties were selling at an approximate 9% discount.

Columns 2 and 3 partition the sample by owner occupation to see whether this inter-temporal increase in the relation between SLR exposure and property values is more pronounced in markets that appear to more rationally price SLR risks. We find that the trend toward more aggressive pricing of SLR risk is concentrated in the non-owner occupied market. The negative and significant Exposed x Time interactions in Column 2 suggests that exposed non-owner occupied properties are priced approximately 13.5% below comparable unexposed properties by the end of our sample period. In contrast, the prices for exposed owner occupied properties do not appear to respond to the increases in SLR projections that occur throughout our sample period. These findings are robust to interacting exposure with a linear (instead of logged) time trend or an indicator for the second half of our sample period.

While precisely estimating which reports are causing the cumulative growth of the discount over time is likely beyond the scope of this paper, we can examine the release of the 2013 IPCC report, which we point out earlier is likely one of the largest consensus expert updates about expected SLR. In Table 9 Panel a conducts an analysis similar to that in Table 8, except that we replace the exposed time trend interaction with an Exposed x Post-IPCC interaction, which equals one for exposed properties after April of 2014 and zero otherwise. We also restrict the sample to periods after 2010, which leaves approximately three years in the pre- and post-IPCC samples. We find that the relation between SLR exposure and property prices is more negative following the 2014 IPCC report release, but only within the non-owner-occupied sample. Again, this result fits squarely with the narrative that, in markets where sophisticated investors are the marginal purchasers, the impact of new information is likely to move prices.

Finally, examining market activity in the period following a major event allows us to examine any changes in transaction volumes accompanying an influx of new information. Again, the model in Bakkensen and Barrage (2017) provides some guidance: as beliefs, and in particular the extent of heterogeneity about future SLR, changes in response to these reports, we should see an increased volume of believers buying from non-believers. As shown in Table 9 Panel b, our results line up with their model in two ways. First, consistent with the idea that as information about SLR risks comes to light, exposed properties should be more likely to transact, Column 1 indicates that the annual probability of turnover is approximately 0.2% higher for exposed properties between 2011 and 2016 (relative to a base transaction rate of approximately 11% for all properties). This is entirely driven by the period following the IPCC report where we see a 0.8% increase in the annual probability of an exposed property transacting as evidenced in Column 2. Columns 3 and 4 partition the sample on owner occupancy. Here, we see the more precise and larger (though not statistically different from one another) coefficient in the owner occupied buyer group—exactly the subset of agents where we find belief heterogeneity matters and where we would expect to find optimistic buyers selecting into exposed properties.

5 Conclusion

We show that home buyers look to the distant horizon when bidding on coastal properties that will be affected by sea level rise under even conservative scientific estimates. We find average discounts in the range of 7% of the home value. However, this discount is driven by the non-owner occupied purchasers—often companies or real estate investors—who are likely to approach the purchase decision in a more sophisticated manner. Non-owner occupied buyers demand a 10% price reduction for SLR effected vs unaffected properties. Moreover, within this segment, the discount for SLR properties has increased over time coinciding with the release of new scientific evidence on the extent and timing of ocean encroachment. Within the owner occupied segment, we find that the discount varies at the county level by the degree to which inhabitants are worried about the effects of climate change: with more worried areas impounding a significant discount and unworried areas demanding no concessions for SLR exposure. These results are robust to a wide range of specifications, but do not hold in our placebo test sample of non-owner occupied rental properties rates, suggesting our effects are driven by concerns about long horizon SLR risks. While we also find evidence that homeowners have recently made less investments in exposed homes. Although this reduced investment has the potential to be costly down the road, it does not yet have significant pricing implications.

In his 2015 state of the union, President Barack Obama named climate change as the single greatest challenge facing humanity. Like many challenges, capitalist societies look toward markets to provide guidance and solutions. Our research represents an important step in understanding the relation between financial markets and climate change by establishing and characterizing the real estate price discount due to sea level rise. Where these risks are priced, there is less scope for wealth transfer between homeowners and less chance of significant and destabilizing downward price volatility in the future. Our research, by documenting the role of information distribution and increased attention in steepening the discount, also suggests that policy interventions, requiring increased risk disclosure for coastal property transactions, may affect the prices of residential real estate.

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Figure 1: NOAA Sea Level Rise Calculator

Figure 1 displays a sample screenshot from the NOAA Sea Level Rise (SLR) viewer of the New York Metropolitan area. The viewer provides an online portal to access the underlying SLR shapefiles which describe, for each coastal area in the Continental USA, detailed data on the properties that will inundated following a 1-6 foot increase in average global ocean level. In this case, the light blue regions of the figure represent properties that will become chronically inundated following a 2 foot increase in global average sea levels.

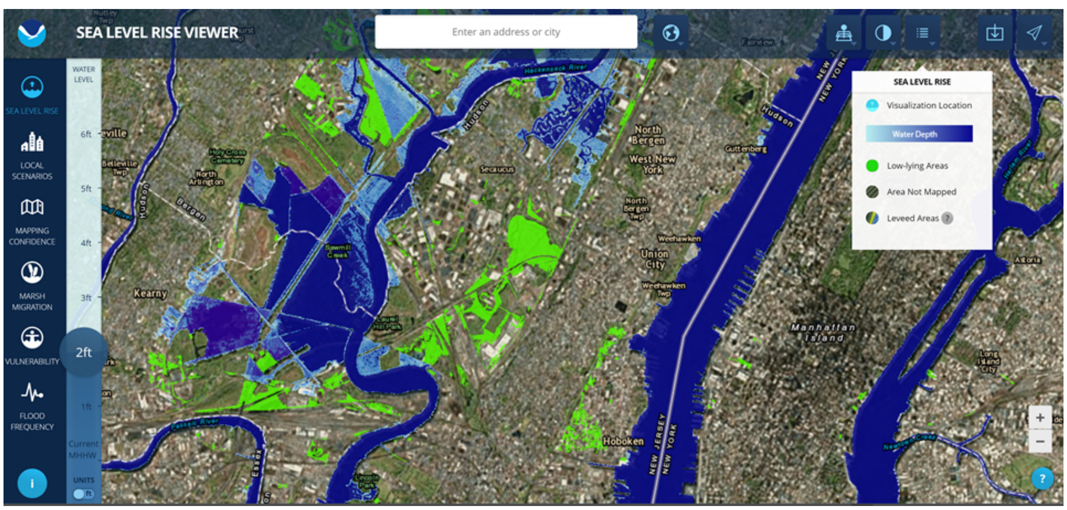


Figure 2: Sea Level Exposures by County

Figure 2 Displays the proportion of exposed transactions in coastal counties within the continental United States. Exposure is measured as an indicator variable that takes a value of 1 if a property will be effected by 0-6 feet of sea level rise. (No Data) refers to any counties without any transacting properties with exposure to SLR of 6 feet or less.

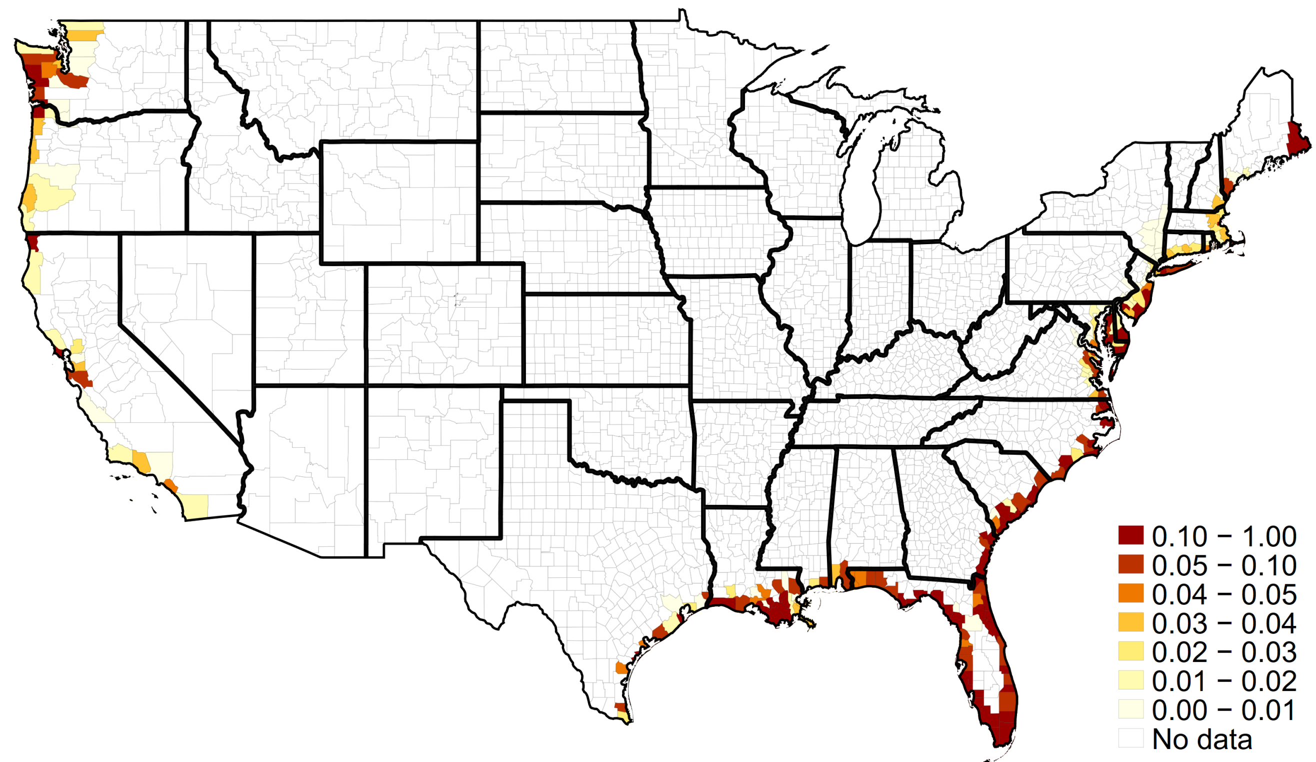
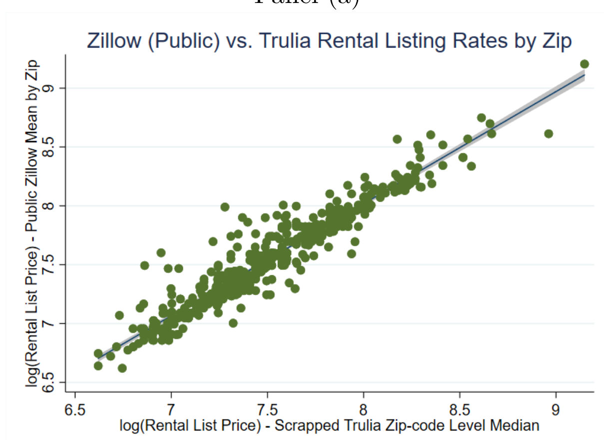


Figure 3: House Prices vs. Rental Rates (Public vs. Private Data) by Zip Code

Figure 3 demonstrates the quality of the rental listing data scrapped by the authors from Trulia.com. Panel a is a scatter plot of the relationship between median log(rental list price) scrapped for individual properties from Trulia.com with the log(rental list price) for aggregate data publicly available by zip code from Zillow.com for November of 2017. Panel b is a scatter plot of the relationship between median log(rental list price) scrapped on November 2017 for individual properties from Trulia.com with the log(median house price) for all property-level transactions from the proprietary ZTRAX database from 2007-2016 at the zip code level.

Panel (a)



Panel (b)

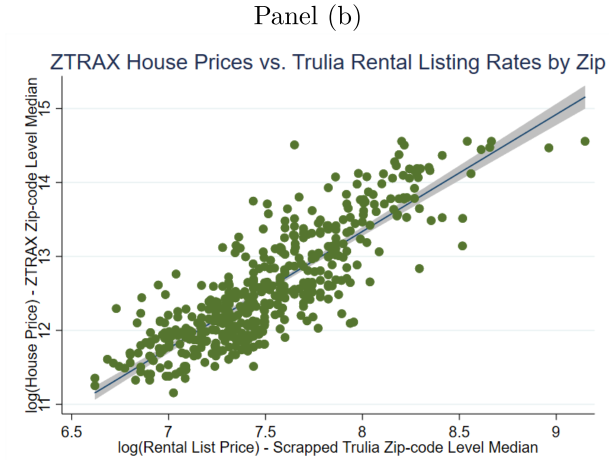
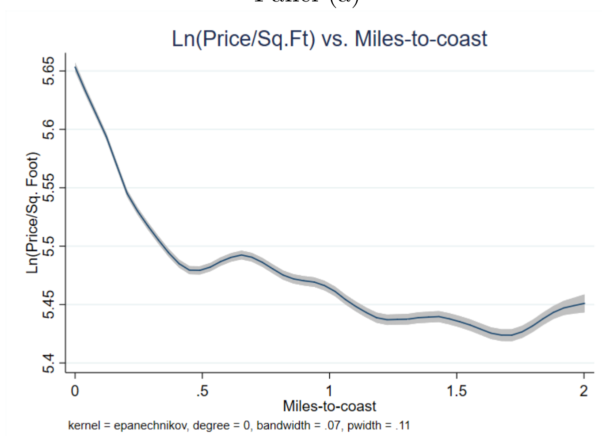


Figure 4: Importance of Distance-to-coast Fixed Effects

Figure 4 demonstrates the importance of controlling for distance to the coast, when trying to evaluate the effect of SLR on home value. Panel a depicts the non-linear relationship, via a smoothed moving average, between the log price per square foot of housing transactions as a function of miles to the coastline without any controls. Panel b is the same as the first, but includes the residual log price per square foot of housing transactions after including fixed effects for zip code interact with time (monthly).

Panel (a)



Panel (b)

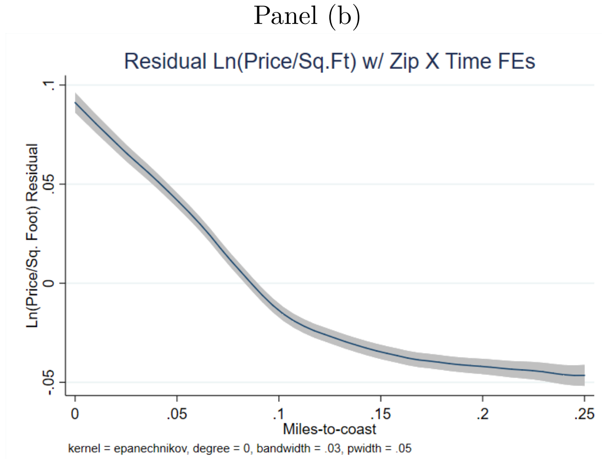


Figure 5: Google Search Trend for "Sea Level Rise"

This Figure displays the Google search intensity for the term *sea level rise* within the United States from 2004-2017. The vertical axis is normalized by the maximum search activity during the period. The vertical green line indicates the release window for parts 2 and 3 of the 2013 IPCC report on climate change.

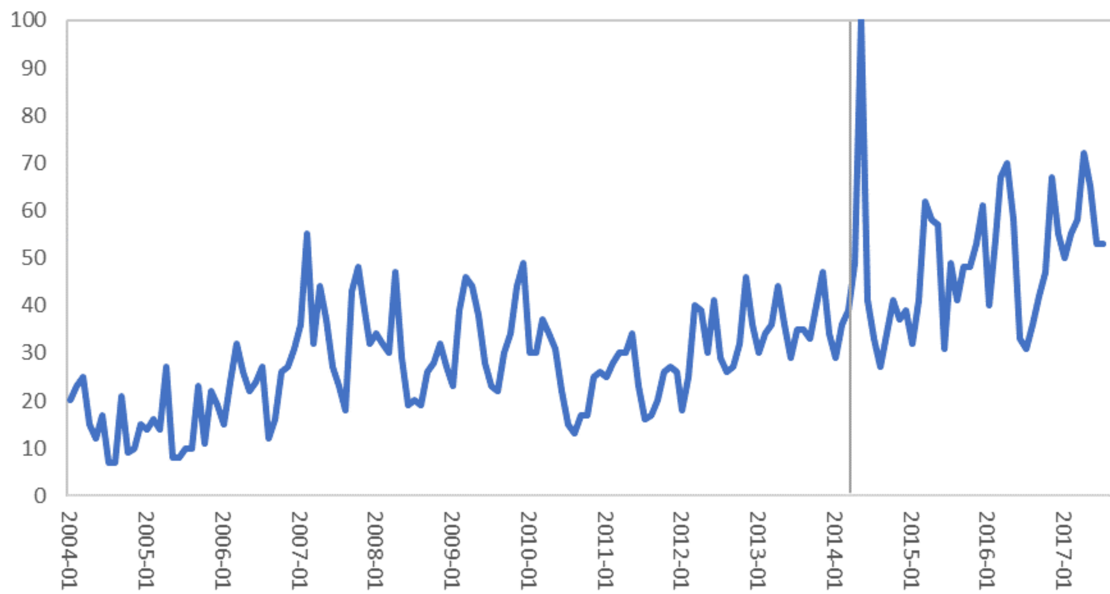


Figure 6: SLR Exposure & House Price Effects

Figure 6 demonstrates the relationship between the % change in house price of exposed (relative to unexposed properties) by the amount of SLR required to make the property underwater. These coefficients are based on a regression of log house price per square foot on categorical dummies for feet of SLR to be exposed after including zip code (Z) x time (T) x distance-to-coast bin (D) x Elevation Bin (E) x owner occupied property and non-local buyer (O) x condominium (P) x total bedrooms (B) fixed effects. Time is measured on a monthly basis, there are seven miles-to-cost bins, corresponding to the following miles-to coast cutoffs: 0.01, 0.02, 0.04, 0.08, and 0.16, and elevation bins are defined in six foot increments based on the elevation above sea level. All columns also include fourth order polynomial controls for the natural log of property age, the natural log of property square footage, and the miles a property is from the coast. Standard errors that are clustered at the zip code level and 95% confidence intervals based on these standard errors are included as bands in the figure.

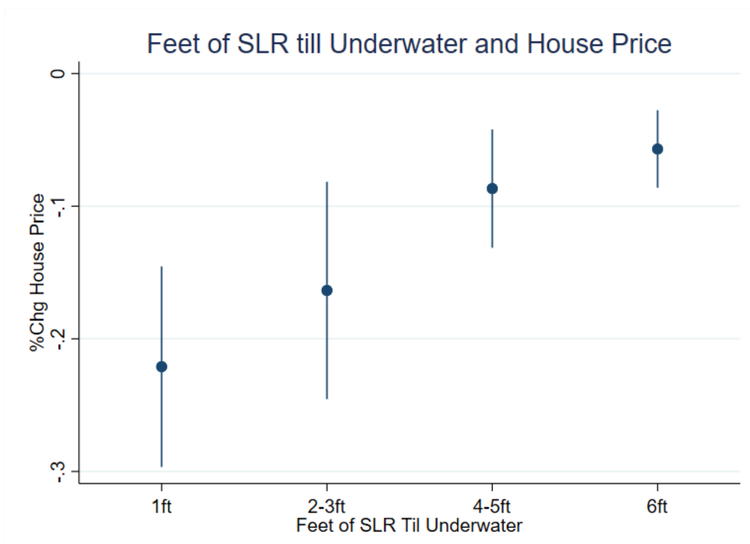


Table 1: Summary Statistcs

This table includes summary statistics from ZTRAXX from 2007 to 2017 (Panel a) and Trulia rental data for November 2017 (Panel b). Properties are restricted to those with 0.25 miles of the beach with all household characteristics and transactions during these time periods. The first group in each panel includes price and price per square foot, while the second group details property and buyer characteristics for both the full sample and exposed properties.

Panel (a)

	Full Coastal Sample			***Exposed=1***		
	Mean	Std.Dev.	Obs	Mean	Std.Dev.	Obs
House Price($1000s)	458.85	584.76	481321	466.23	563.11	144880
House Price ($)/Sq. Ft	907.82	8545.76	481321	1025.51	8179.80	144880
ZTRAX Housing Property Characteristics						
Building Sq. Ft.	1702.95	3122.54	481321	1669.65	2408.42	144880
# Bedrooms	1.55	1.64	481321	1.20	1.54	144880
Property Age (log)	3.31	1.10	463039	3.26	1.02	140606
Owner Occupied	0.61	0.49	481321	0.51	0.50	144880
Miles-to-coast (miles)	0.12	0.07	481321	0.08	0.07	144880
Elevation Above Sea Level (meters)	7.09	9.37	481320	2.23	1.82	144880
Exposed (underwater w/ <=6ft SLR)	0.30	0.46	481321	1.00	0.00	144880
Feet of SLR til Property Underwater				4.42	1.37	144880

Panel (b)

	Full Coastal Sample			***Exposed=1***		
	Mean	Std.Dev.	Obs	Mean	Std.Dev.	Obs
Trulia Rental Listing Data						
Rental Listing Price/Mo($)	6127.84	11242.73	17678	5984.80	10820.81	3821
Rental Listing Rate($)/Sq. Ft	4.54	5.84	10830	4.68	6.06	2166
Trulia Rental Listing Property Characteristics						
Sq. Ft.	1543.88	1054.67	10846	1479.61	982.33	2169
# Bedrooms	2.25	1.33	17706	2.26	1.31	3827
Miles-to-coast (miles)	0.13	0.07	17706	0.10	0.07	3827
Elevation Above Sea Level (meters)	7.69	8.92	17706	2.29	0.99	3827
Exposed (underwater w/ <=6ft SLR)	0.22	0.41	17706	1.00	0.00	3827
Feet of SLR til Property Underwater				4.62	1.29	3827

Table 2: Main Regression Results

This table presents ordinary last squares estimates where the dependent variable is Ln(Sale Price) in Column 1 and Ln(Price/Sq. Foot) in Columns 2, 3 , 4 and 5. The explanatory variable of interest is SLR Exposed, which equals one for a property that would be inundated with a 6 foot SLR and zero otherwise. The sample is restricted to sales of residential properties within 0.25 miles of the coast between 2007 and 2016. Column 5 presents the results without fixed effects to indicate the importance of our specifications. Columns 1 through 3 include zip code (Z) x time (T) x distance-to-coast bin (D) x total bedrooms (B) fixed effects. Time is measured on a monthly basis and there are seven distance-to-coast bins, corresponding to the following miles to coast cutoffs: 0.01, 0.02, 0.04, 0.08, and 0.16. Columns 3 and 4 add fourth order polynomial controls for the natural log of property age, the natural log of property square footage, and the miles a property is from the coast. Column 4 enhances the fixed effects structure by further interacting the existing fixed effects with indicators for an owner occupied property or a property sold to a non-local buyer (O), a condominium property (P), and the property elevation bin (E), defined in two meter intervals. T-statistics based on standard errors that are clustered at the zip code level are presented below the coefficients. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	With Fixed Effects				No Fixed Effects
	(1)	(2)	(3)	(4)	(5)
	Ln(Price)	Ln(Pr/SqFt)	Ln(Pr/SqFt)	Ln(Pr/SqFt)	Ln(Pr/SqFt)
SLR Exposed	-0.080***	-0.059***	-0.089***	-0.078***	0.068**
	(-3.99)	(-3.03)	(-3.85)	(-5.07)	(2.29)
Ln(Square Feet)			1.639**	1.498**	
			(2.34)	(2.27)	
Ln(Square Feet)^2			-0.988***	-0.947***	
			(-4.97)	(-5.07)	
Ln(Square Feet)^3			0.131***	0.128***	
			(5.51)	(5.75)	
Ln(Square Feet)^4			-0.006***	-0.006***	
			(-5.56)	(-6.07)	
Miles to Coast			-3.247	-8.648***	
			(-1.57)	(-4.51)	
Miles to Coast^2			20.964	84.660***	
			(0.84)	(3.87)	
Miles to Coast^3			-99.345	-387.054***	
			(-0.79)	(-3.60)	
Miles to Coast^4			194.382	644.334***	
			(0.88)	(3.37)	
Ln(Property Age)			0.108**	0.059	
			(2.03)	(0.85)	
Ln(Property Age)^2			0.050	0.079	
			(1.00)	(0.98)	
Ln(Property Age)^3			-0.063***	-0.074***	
			(-3.90)	(-2.79)	
Ln(Property Age)^4			0.010***	0.011***	
			(5.83)	(4.08)	
Z x T x D x B	Y	Y	Y	N	N
Z x T x D x E x O x P x B	N	N	N	Y	N
R^2	0.740	0.562	0.897	0.933	0.001
Adjusted R^2	0.622	0.366	0.850	0.891	0.001
N	296384	276074	262173	130504	481321

Table 3: Robustness to Flooding

This table presents ordinary last squares estimates where the dependent variable is Ln(Price/Sq. Foot) in Columns 1, 2 and 3, Ln(Property Age) in Column 4, and Ln(Sq. Feet) in Column 5. The explanatory variable of interest is SLR Exposed, which equals one for a property that would be inundated with a 6 foot SLR and zero otherwise. The sample is restricted to sales of residential properties within 0.25 miles of the coast between 2007 and 2016. Column 1 (2) further restrict the sample by excluding properties in counties that have been flooded in the current or past three years. Column 2 makes a similar restriction, excluding counties where FEMA triggered the individuals and household damage aid program (available since 2000). All columns include zip code (Z) x time (T) x distance-to-coast bin (D) x Elevation Bin (E) x owner occupied property and non-local buyer (O) x condominium (P) x total bedrooms (B) fixed effects. Time is measured on a monthly basis, there are seven miles-to-cost bins, corresponding to the following miles-to coast cutoffs: 0.01, 0.02, 0.04, 0.08, and 0.16, and elevation bins are defined in six foot increments based on the property elevation above sea level. All columns also include fourth order polynomial controls for the natural log of property age, the natural log of property square footage, and the miles a property is from the coast. T-statistics based on standard errors that are clustered at the zip code level are presented below the coefficients. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	(1) Ln(Pr/SqFt)	(2) Ln(Pr/SqFt)	(3) Ln(Pr/SqFt)	(4) Ln(Property Age)	(5) Ln(Square Feet)
SLR Exposed	-0.077***	-0.054***	-0.081***	-0.011	-0.021
	(-4.70)	(-3.22)	(-3.68)	(-0.26)	(-1.05)
Sample Constraint	No Curr Flood	No Hist IH	No View//Appeal		
Sqft Ctrls	Y	Y	Y	Y	Y
Distance to Coast Ctrls	Y	Y	Y	Y	Y
Age Ctrls	Y	Y	Y	Y	Y
Z x T x D x E x O x P x B	Y	Y	Y	Y	Y
R^2	0.940	0.949	0.933	0.815	0.593
Adjusted R^2	0.904	0.917	0.891	0.697	0.338
N	92031	52563	94689	133826	138305

Table 4: Rental Placebo Test

This table presents ordinary least squares estimates where the dependent variable is Ln(Rental Price/Sq. Foot). The explanatory variable of interest is SLR Exposed, which equals one for a property that would be inundated with a 6 foot SLR and zero otherwise. The sample is restricted to residential properties within 0.25 miles of the coast and all listings are scraped in November of 2017. All regressions include zip code (Z) x distance-to-coast bin (D) indicators for an owner occupied property or a property sold to a non-local buyer (O), a condominium property (P), as well as fixed effects for the number of bedrooms (B) and the property elevation bin (E), defined in two meter intervals. We use seven distance-to-coast bins, corresponding to the following miles to coast cutoffs: 0.01, 0.02, 0.04, 0.08, and 0.16. Column 2 excludes flooded properties. Columns 1 and 2 display T-statistics based on standard errors that are clustered at the zip code while columns 3 and 4 simply use robust standard errors. Columns 1, 2 and 4 also include fourth order polynomial controls for the natural log of property age, the natural log of property square footage, and the miles a property is from the coast. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)
SLR Exposed	-0.009	-0.025	-0.003	-0.009
	(-0.37)	(-0.88)	(-0.29)	(-0.74)
Exclude Flooded	No	Yes	No	No
Sqft Ctrls	Y	Y	N	Y
Distance to Coast Ctrls	Y	Y	N	Y
Z x D x B				N
Z x D x E x B	Y	Y	Y	Y
Cluster Level	Zip	Zip	Robust	Robust
R^2	0.818	0.916	0.804	0.818
Adjusted R^2	0.775	0.883	0.758	0.775
N	28672	7251	28672	28672

Table 5: Property Investment

This table presents ordinary least squares estimates where the dependent variable in column 1 a dummy for whether the property was remodeled after 2006, column 2 is a dummy for whether the property was remodeled prior to 2007, and columns 3-4 is the price per square foot as in previous regressions. The explanatory variable of interest is SLR Exposed, which equals one for a property that would be inundated with a 6 foot SLR and zero otherwise. The sample is restricted to sales of residential properties within 0.25 miles of the coast between 2007 and 2016. All columns include zip code (Z) x time (T) x distance-to-coast bin (D) x Elevation Bin (E) x owner occupied property and non-local buyer (O) x condominium (P) x total bedrooms (B) fixed effects. Time is measured on a monthly basis, there are seven miles-to-cost bins, corresponding to the following miles-to coast cutoffs: 0.01, 0.02, 0.04, 0.08, and 0.16, and elevation bins are defined in six foot increments based on the propertys elevation above sea level. All columns also include fourth order polynomial controls for the natural log of property age, the natural log of property square footage, and the miles a property is from the coast. T-statistics based on standard errors that are clustered at the zip code level are presented below the coefficients. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	(1) Remodeled $>$ 2006 (d)	(2) Remodeled $\leq$ 2006 (d)	(3) Ln(Pr/SqFt)	(4) Ln(Pr/SqFt)
SLR Exposed	-0.003**	0.001	-0.078***	-0.086***
	(-2.12)	(0.26)	(-5.02)	(-5.21)
Excludes Remodeled	None	None	$>$ 2006	$\leq$ 2006
Sqft Ctrls	Y	Y	Y	Y
Distance to Coast Ctrls	Y	Y	Y	Y
Age Ctrls	Y	Y	Y	Y
Z x T x D x E x O x P x B	Y	Y	Y	Y
R^2	0.748	0.838	0.933	0.933
Adjusted R^2	0.588	0.735	0.890	0.891
N	130504	130504	128274	117513

Table 6: Exposure and Market Segmentation

This table presents ordinary last squares estimates where the dependent variable is Ln(Price/Sq. Foot). The explanatory variable of interest is SLR Exposed, which equals one for a property that would be inundated with a 6 foot SLR and zero otherwise, along with its interaction with an indicator for a non-owner occupied property (Columns 1 and 4), a property sold to a non-local buyer (Columns 2 and 4), and a condominium property (Columns 3 and 4). The sample is restricted to sales of residential properties within 0.25 miles of the coast between 2007 and 2016. All columns include zip code (Z) x time (T) x distance-to-coast bin (D) x Elevation Bin (E) x owner occupied property and non-local buyer (O) x condominium (P) x total bedrooms (B) fixed effects. Time is measured on a monthly basis, there are seven miles-to-cost bins, corresponding to the following miles-to coast cutoffs: 0.01, 0.02, 0.04, 0.08, and 0.16, and elevation bins are defined in six foot increments based on the propertys elevation above sea level. All columns also include fourth order polynomial controls for the natural log of property age, the natural log of property square footage, and the miles a property is from the coast. T-statistics based on standard errors that are clustered at the zip code level are presented below the coefficients. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)
SLR Exposed	-0.030*	-0.035**	-0.054***	-0.027*
	(-1.89)	(-2.28)	(-2.78)	(-1.80)
Exposed x Non-Owner Occupied	-0.080***			-0.076**
	(-3.85)			(-2.33)
Exposed x Non-Local Buyer		-0.061***		-0.010
		(-3.41)		(-0.40)
Exposed x Condo			-0.043	0.003
			(-1.36)	(0.07)
Sqft Ctrls	Y	Y	Y	Y
Distance to Coast Ctrls	Y	Y	Y	Y
Age Ctrls	Y	Y	Y	Y
Z x T x D x E x O x P x B	Y	Y	Y	Y
R^2	0.933	0.933	0.933	0.933
Adjusted R^2	0.891	0.891	0.891	0.891
N	130504	130504	130504	130504

Table 7: Beliefs and the Price of Exposure

This table presents ordinary last squares estimates where the dependent variable is Ln(Price/Sq. Foot). The explanatory variable of interest is SLR Exposed, which equals one for a property that would be inundated with a 6 foot SLR and zero otherwise, along with its interaction with Worried, a standardized measures of a county's level of concern regarding SLR as defined in Appendix A. The sample is restricted to sales of residential properties within 0.25 miles of the coast between 2007 and 2016. Column 2 (3) further restricts the sample to non-owner occupied (owner-occupied) properties. All columns include zip code (Z) x time (T) x distance-to-coast bin (D) x Elevation Bin (E) x owner occupied property and non-local buyer (O) x condominium (P) x total bedrooms (B) fixed effects. Time is measured on a monthly basis, there are seven miles-to-cost bins, corresponding to the following miles-to coast cutoffs: 0.01, 0.02, 0.04, 0.08, and 0.16, and elevation bins are defined in six foot increments based on the property elevation above sea level. All columns also include fourth order polynomial controls for the natural log of property age, the natural log of property square footage, and the miles a property is from the coast. T-statistics based on standard errors that are clustered at the zip code level are presented below the coefficients. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)
SLR Exposed	-0.081***	-0.098***	-0.028*
	(-5.21)	(-4.54)	(-1.82)
Exposed x Worried	-0.016	0.019	-0.053***
	(-0.78)	(0.52)	(-2.97)
Occupancy	All	Non-OO	OO
Sqft Ctrls	Y	Y	Y
Distance to Coast Ctrls	Y	Y	Y
Age Ctrls	Y	Y	Y
Z x T x D x E x O x P x B	Y	Y	Y
R^2	0.933	0.891	0.957
Adjusted R^2	0.891	0.834	0.926
N	130504	55292	75212

Table 8: Price of SLR Over Time

This table presents ordinary last squares estimates where the dependent variable is Ln(Price/Sq. Foot). The explanatory variable of interest is SLR Exposed, which equals one for a property that would be inundated with a 6 foot SLR and zero otherwise, along with its interaction with Time, measured as the natural log of the number of months passed since the beginning of our sample in January of 2007. The sample is restricted to sales of residential properties within 0.25 miles of the coast between 2007 and 2016. Column 2 (3) further restricts the sample to non-owner occupied (owner-occupied) properties. All columns include zip code (Z) x time (T) x miles-to-coast bin (D) x elevation bin (E) x owner occupied property and non-local buyer (P) x condominium (C) x total bedrooms (B) fixed effects. Time is measured on a monthly basis, there are seven miles-to-cost bins, corresponding to the following miles-to coast cutoffs: 0.01, 0.02, 0.04, 0.08, and 0.16, and elevation bins are defined in six foot increments based on the property elevation above sea level. All columns also include fourth order polynomial controls for the natural log of property age, the natural log of property square footage, and the miles a property is from the coast. T-statistics based on standard errors that are clustered at the zip code level are presented below the coefficients. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)
SLR Exposed	0.001	0.011	-0.019
	(0.03)	(0.26)	(-0.44)
Exposed x Time	-0.020**	-0.029***	-0.003
	(-2.54)	(-2.77)	(-0.28)
Occupancy	All	Non-OO	OO
Sqft Ctrls	Y	Y	Y
Distance to Coast Ctrls	Y	Y	Y
Age Ctrls	Y	Y	Y
Z x T x D x E x O x P x B	Y	Y	Y
R^2	0.933	0.891	0.957
Adjusted R^2	0.891	0.834	0.926
N	130504	55292	75212

Table 9: Prices and Trading Following the 2013 IPCC Report

This table presents ordinary least squares estimates where the dependent variable is either Ln(Price/Sq. Foot)—Panel a—or an indicator if a particular property transacted in a given year—Panel b. The explanatory variable of interest is SLR Exposed, which equals one for a property that would be inundated with a 6 foot SLR and zero otherwise, along with its interaction with Post-IPCC, which equals one for transactions occurring after April of 2014 and zero otherwise. The sample is restricted to sales of residential properties within 0.25 miles of the coast between 2011 and 2016. In all regressions we include zip code (Z) x time (T) x distance-to-coast bin (D) x Elevation Bin (E) x owner occupied property and non-local buyer (O) x condominium (P) x total bedrooms (B) fixed effects, and In Panel a Column 2 (3) and Panel b column 3 (4) restricts the sample to non-owner occupied (owner-occupied) properties. Time is measured on a monthly basis, there are seven miles-to-cost bins, corresponding to the following miles-to coast cutoffs: 0.01, 0.02, 0.04, 0.08, and 0.16, and elevation bins are defined in six foot increments based on the elevation above sea level. All columns also include fourth order polynomial controls for the natural log of property age, the natural log of property square footage, and the miles a property is from the coast. T-statistics based on standard errors that are clustered at the zip code level are presented below the coefficients. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Panel (a) Price

	(1)	(2)	(3)
SLR Exposed	-0.070***	-0.081***	-0.025
	(-3.49)	(-3.74)	(-0.88)
Exposed x Post-IPCC	-0.024	-0.059*	0.004
	(-0.89)	(-1.88)	(0.13)
Occupancy	All	Non-OO	OO
Sqft Ctrls	Y	Y	Y
Distance to Coast Ctrls	Y	Y	Y
Age Ctrls	Y	Y	Y
Z x T x D x E x O x P x B	Y	Y	Y
R^2	0.924	0.879	0.952
Adjusted R^2	0.875	0.813	0.915
N	69195	31247	37948

Panel (b) Trading Volume

	(1)	(2)	(3)	(4)
SLR Exposed	0.002**	-0.002	-0.002	-0.002
	(2.07)	(-1.04)	(-0.55)	(-1.05)
Exposed x Post-IPCC		0.008**	0.007	0.008**
		(2.56)	(1.57)	(2.40)
Occupancy	All	All	Non-OO	OO
Sqft Ctrls	Y	Y	Y	Y
Distance to Coast Ctrls	Y	Y	Y	Y
Age Ctrls	Y	Y	Y	Y
Z x T x D x E x O x P x B	Y	Y	Y	Y
R^2	0.196	0.197	0.226	0.181
Adjusted R^2	0.050	0.049	0.066	0.039
N	1700088	1616358	577578	1038780