Lecture 13

Hedonics and Real Estate Markets

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AEM 4510

Roadmap

- What can we use to infer the demand for environmental goods?
- What do housing prices tell us?
- What is the demand for hazardous waste? (Greenstone and Gallagher, 2008)
- What is the demand for sea level rise? (Bernstein, et al. 2019)

Hedonic valuation

Revealed preference approaches

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Is there a way we can reveal the value of these goods?

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If there are changes in the environmental good, holding everything else fixed, that should be reflected in *some way* in changes in the price of the related private good

This change in price can tell us something about how people value the change in the environmental good

Revealed preference approaches: example

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What does this price change mean?

Hedonics: Property value models

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- Rooms
- Bathrooms
- School quality
- **Environmental quality**

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Homes located in pristine areas are likely to be more valuable than identical homes located near toxic facilities

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e.g. homes in better school districts are typically more expensive

BCA of Superfund

Superfund


The Love Canal Disaster: Toxic Waste in the Ne...
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By 2005: $35 billion in federal funding has been spent at roughly 800 sites

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How do we do it?

Superfund

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Main idea: Take two otherwise very similar houses: one in a neighborhood surrounding a site that has been cleaned up and one in a neighborhood surrounding a site that has not

How do their prices differ?

The hedonic method

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It motivated the conceptual model of Rosen (1974) of how we might use hedonic prices to estimate peoples' values for site-specific amenities

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Environmental quality (air quality, noise, etc)

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Lets get some intuition for how housing markets reveal the value of environmental goods

Hedonics intuition: L.O. Taylor, 2003

Imagine the following hypothetical scenario in which there are two identical lakes each with 100 identical homes surrounding them

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At the current equilibrium price of $200,000 per house, all 200 hundred homes on either lake are equally preferred

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Lake A prices **increase** to bring the market back into equilibrium

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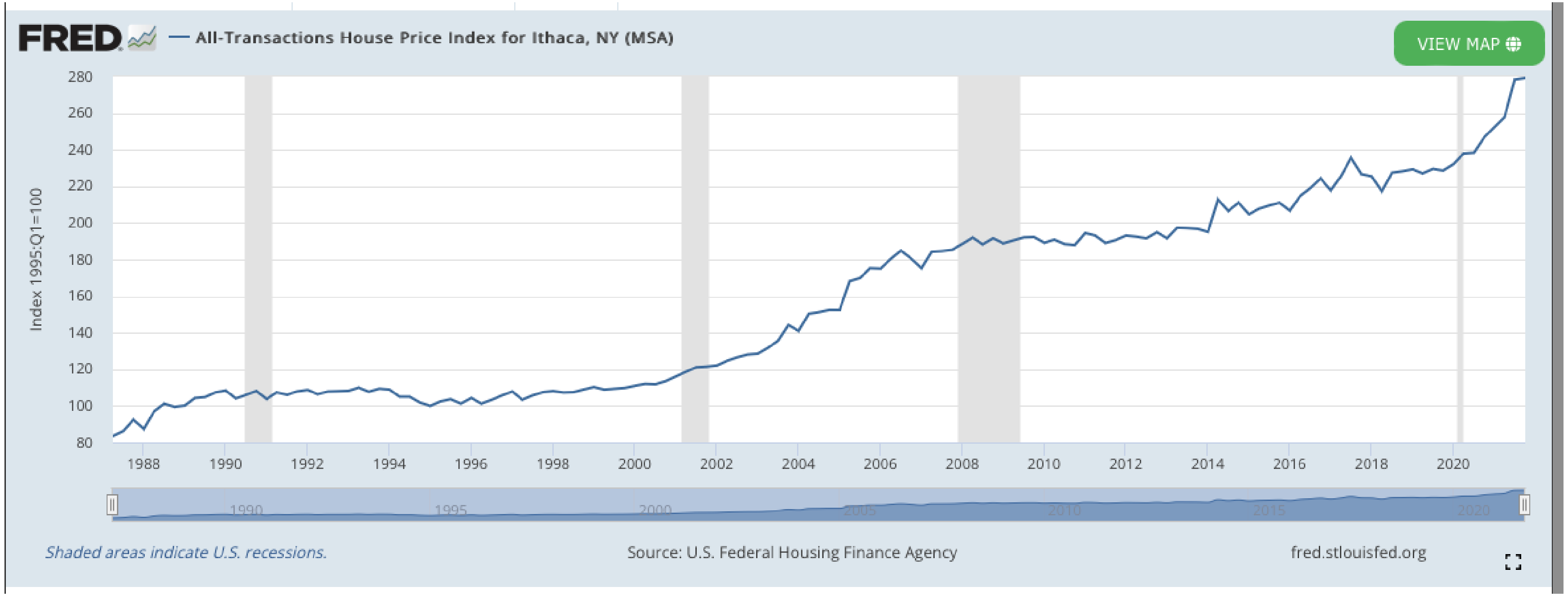
Sidebar: think about US cities in the last 20 years and urban residential prices

Housing prices in Ithaca are increasing fast, why?

Study shows Ithaca home prices rising far faster than nation's



Another Dyson professor's house

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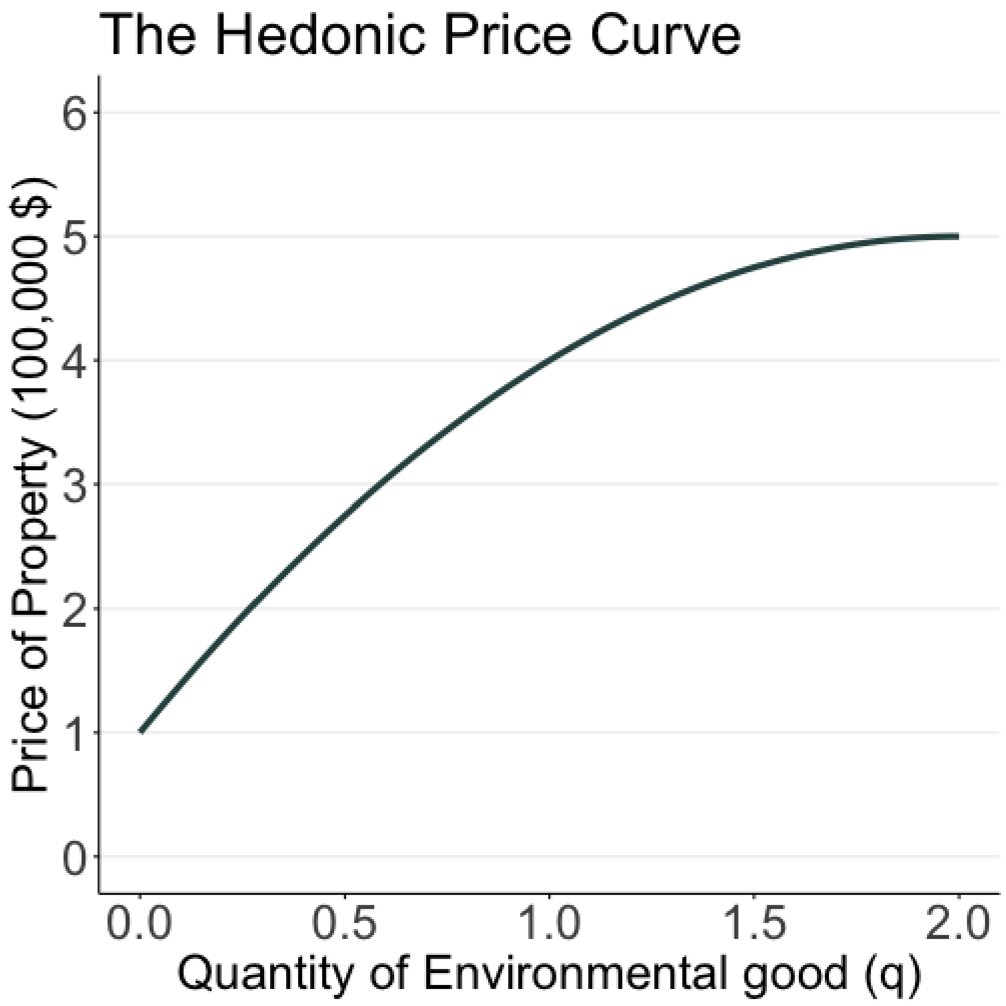
Here we will assume the supply of houses is fixed in the short run so the price curve arises solely from buyer behavior

The hedonic model: the price curve



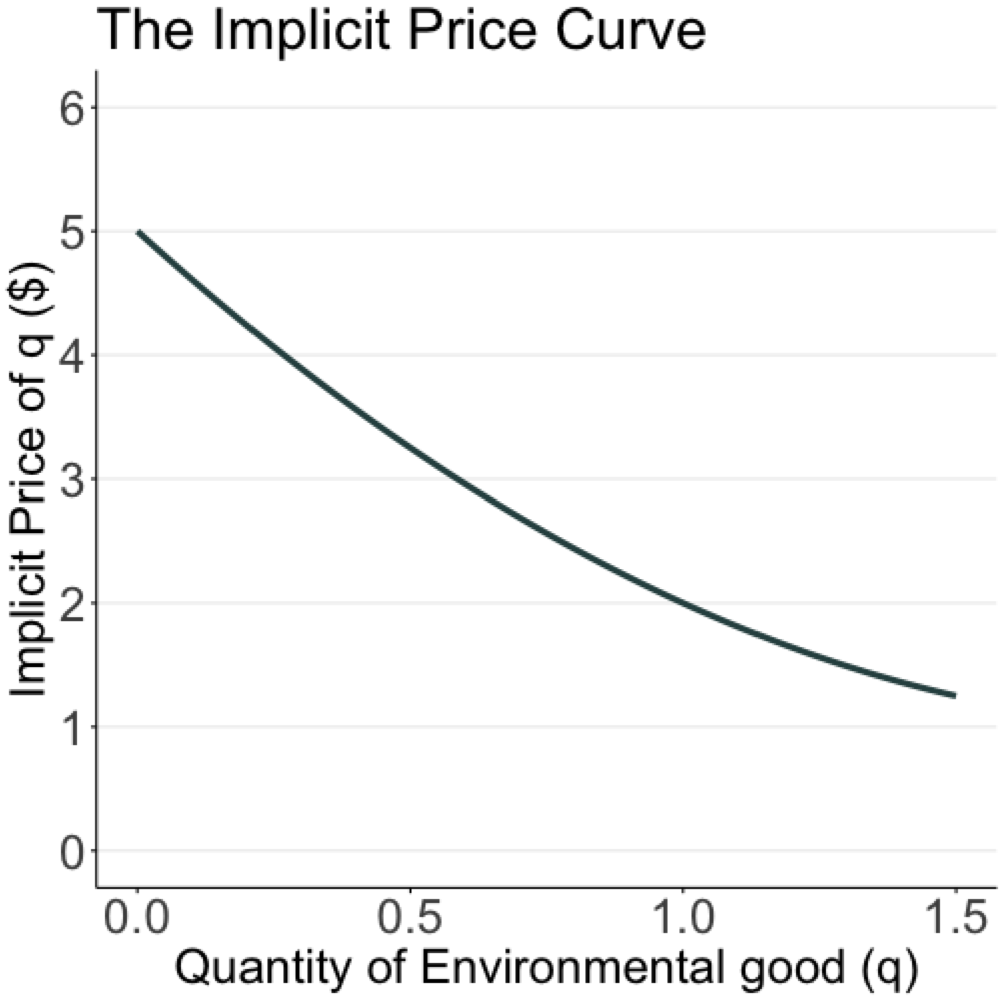
The hedonic price curve is $P(x, q)$

It's increasing in q (q is good) but at a decreasing rate (decreasing marginal utility)

This is holding x fixed

Analogous to regular demand curves holding income fixed

The hedonic model: the price curve



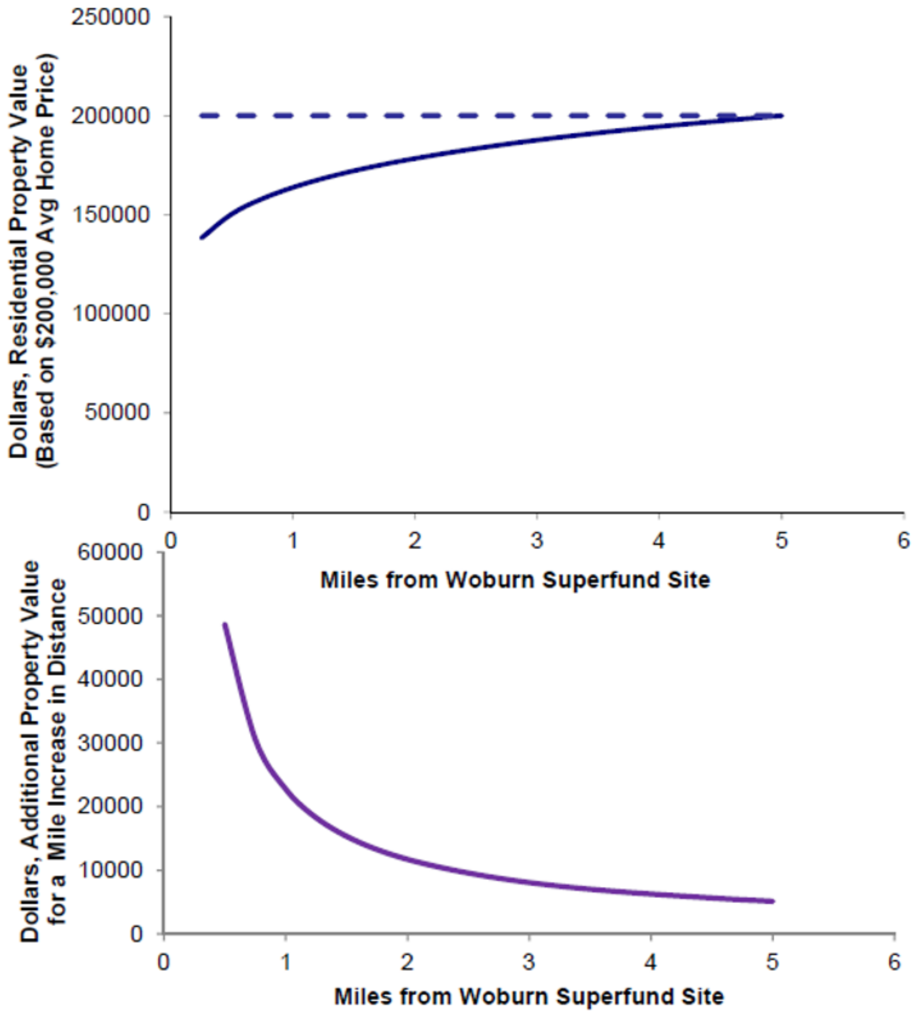
The implicit price curve for q is $\frac{\partial P(x,q)}{\partial q}$

It tells us how the price changes in q

It's positive, but downward sloping

This is effectively the environmental good demand curve

Price curve example



Total Value

“Marginal” Value
(one mile increment)

Source: Messer et al. *Env. and Res. Econ*. 2006

The hedonic model: consumer's choice problem

Households buy a single property given their budget constraint and their preferences for housing characteristics

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- z is the numeraire good (spending on other private goods)
- y is income
- s is the set of the household's characteristics like family size, ages, etc

Unrealistic pieces of the model

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We won't touch on this in class because it's a lot more complicated, but economists know how to deal with these problems

Choosing q

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We are thus also implicitly assuming q varies across space so that households can sort into areas they prefer

- q is really picking up **local** environmental goods

What is $P(x, q)$

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This clearly works well for renting households

For homeowners we are basically assuming they rent from themselves every year

The hedonic model: consumer's choice problem

$$\max_{x,q,z} U(x,q,z;s) \quad \text{subject to:} \quad y = z + P(x,q)$$

Plug in the constraint for z to get:

$$\max_{x,q} U(x,q,\underbrace{y - P(x,q)}_{z};s)$$

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The FOCs for this problem are:

$$\frac{\partial U}{\partial x_j} = \frac{\partial U}{\partial z}\frac{\partial P}{\partial x_j} \quad j = 1,\ldots,J \quad \text{(house characteristics)}$$
$$\frac{\partial U}{\partial q} = \frac{\partial U}{\partial z}\frac{\partial P}{\partial q} \quad \text{(environmental good)}$$

The hedonic model: consumer's choice problem

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What does this mean?

The hedonic model: consumer's choice problem

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Recall from intro/intermediate micro: the MRS tells us how the household trades off q and z while keeping utility constant

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How prices change in the environmental good, *holding all else constant*, tells us about WTP

The hedonic model in practice

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e.g. what if air quality improved in Syracuse because we are in a recession?

- Recessions make air quality better and prices higher (polluters aren't producing as much because demand is low)
- But recessions also decrease demand for houses and make prices lower (people are unemployed)

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The housing prices went up **despite** the recession!

The hedonic model in practice

How do we get around this?

Find a control city (e.g. Ithaca): houses that were also hit by the recession but **didn't** have an air quality improvement (why? maybe no polluters near by)

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The change in prices of Ithaca houses tells us the impact of the recession, if we subtract it from the change in prices of Syracuse homes we get the effect of air quality alone!

- Syracuse price change - ithaca price change = air quality effect
- (air quality effect + recession effect) - (recession effect) = air quality effect

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Subtract this change from the

Housing prices and superfund clean up

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Main question: How does superfund site clean up affects the housing price in the adjacent areas?

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Main question: How does superfund site clean up affects the housing price in the adjacent areas?

How they do it: Compare housing market outcomes in the areas surrounding the first 400 hazardous sites chosen for Superfund clean-ups to the areas surrounding the 290 sites that narrowly missed qualifying for these clean-ups

Housing prices and superfund clean up

Each site is given a Hazardous Ranking System (HRS) Score (0-100)

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Cutoff is **arbitrary** (imposed by congressional budget constraints)

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Cutoff is **arbitrary** (imposed by congressional budget constraints)

Places right below 28.5 probably aren't systematically different than those right above 28.5

Housing prices and superfund clean up

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Cutoff is **arbitrary** (imposed by congressional budget constraints)

Places right below 28.5 probably aren't systematically different than those right above 28.5

Key idea: Any differences between housing values in these locations is most likely due to Superfund clean up, not other factors

Superfund location

Figure IIa
GEOGRAPHIC DISTRIBUTION OF HAZARDOUS WASTE SITES IN THE 1982 HRS SAMPLE
SITES WITH 1982 HRS SCORES EXCEEDING 28.5

Figure IIb
GEOGRAPHIC DISTRIBUTION OF HAZARDOUS WASTE SITES IN THE 1982 HRS SAMPLE
SITES WITH 1982 HRS SCORES BELOW 28.5

Regression

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They regress:

$$\log(\text{2000 median home price})_c = \theta \underbrace{1(\text{cleaned up in 2000})_c}_{= 1 \text{ if true}, = 0 \text{ otherwise}} + \beta \underbrace{X_c}_{\text{controls}} + \varepsilon_c$$

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$-\theta$ is telling us the **cost** of a superfund site to households

Superfund results: "quasi-experimental"

QUASI-EXPERIMENTAL ESTIMATES OF THE EFFECT OF NPL STATUS ON HOUSE PRICES, SAMPLES BASED ON THE 1982 HRS SAMPLE SITES

					RD-Style Estimators		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
			A. Own Census Tract				
1(NPL Status by 2000)	0.035	0.037	0.043	0.047	0.007	0.022	0.027
	(0.031)	(0.035)	(0.031)	(0.027)	(0.063)	(0.042)	(0.038)
			B. Adjacent Census Tracts				
1(NPL Status by 2000)	0.071	0.066	0.012	0.015	-0.006	-0.002	0.001
	(0.031)	(0.035)	(0.029)	(0.022)	(0.056)	(0.035)	(0.035)
			C. 2-Mile Radius from Hazardous Waste Sites				
1(NPL Status by 2000)	0.021	0.019	0.011	0.001	0.023	-0.018	-0.007
	(0.028)	(0.032)	(0.029)	(0.023)	(0.054)	(0.035)	(0.034)
Ho: > 0.138, P-Value	0.000	0.000	0.000	0.000	0.018	0.000	0.000

Top row of the last three columns are the important ones

Superfund results

Superfund cleanups had **economically and statistically insignificant effects** on property values, rental rates, housing supply, population, who lives near the site: 0.7-2.7% depending on the model

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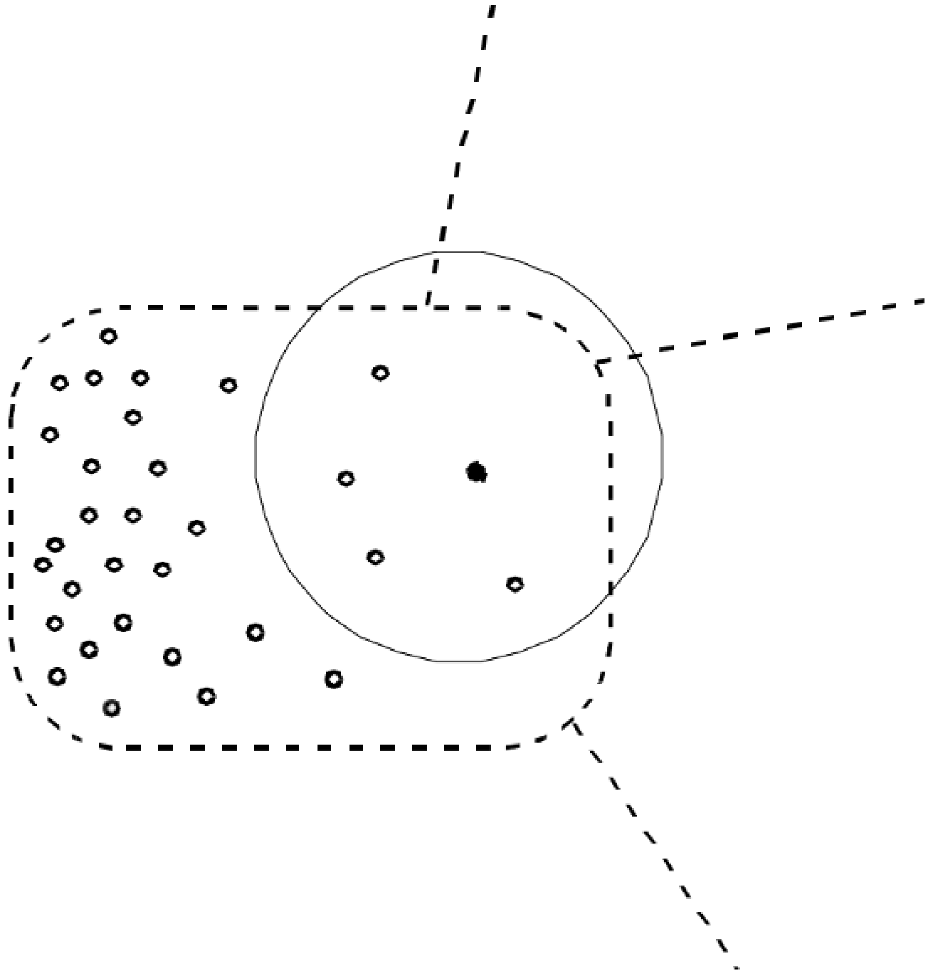
Why does granularity matter?

Superfund: zoom in

Superfund sites are a localized disamenity

Previous attempts to value cleanup looked at changes in census tract median housing values and found no impacts

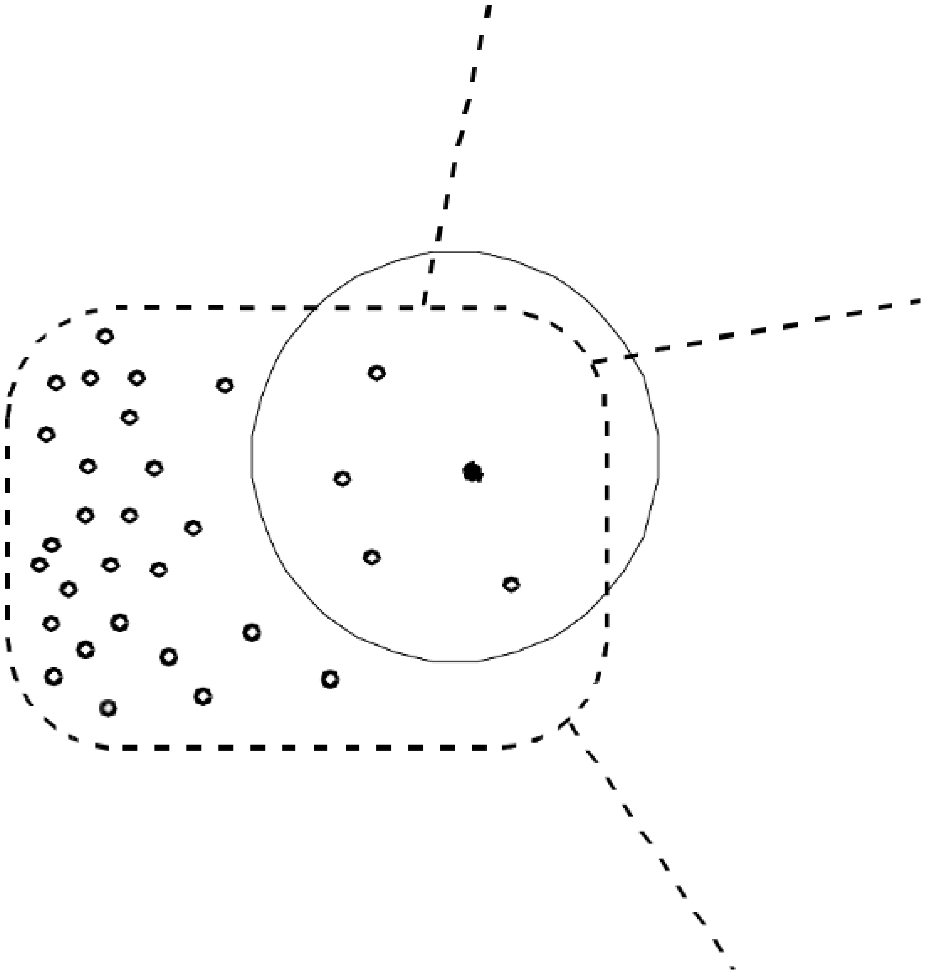
Need to look **within** census tracts



Superfund: zoom in

Consider changes in other percentiles of within-tract house value distribution:

deletion of a site raises tract-level housing values by 18.2% at the 10th percentile, 15.4% at the median, and 11.4% at the 60th percentile



Sea level rise

Sea level rise (SLR) is a long run phenomenon

Not a lot of flooding now, but by 2050 sizable portions of NYC will be flooded

By 2100 average SLR will be over 2 feet

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Yes, why?

Let's work through the logical steps

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Effects decades in the future can affect current prices

Sea level rise

Here's an alternative way to think about it: property as an investment

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- Pay an upfront cost (mortgage)
- Get a future stream of revenues (rental payments from renters)

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Houses are kind of like annuities:

- Pay an upfront cost (mortgage)
- Get a future stream of revenues (rental payments from renters)

The price of an annuity should be equal to the present value of the stream of payments (minus upkeep costs)

- Think about why this must be true

Sea level rise

The price of a house is the present value of the stream of profit: rental payments minus upkeep costs

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If SLR reduces future demand for rentals (decreases rental payments) or increases upkeep costs (e.g. more maintenance of the house), future rental profit goes down

Sea level rise

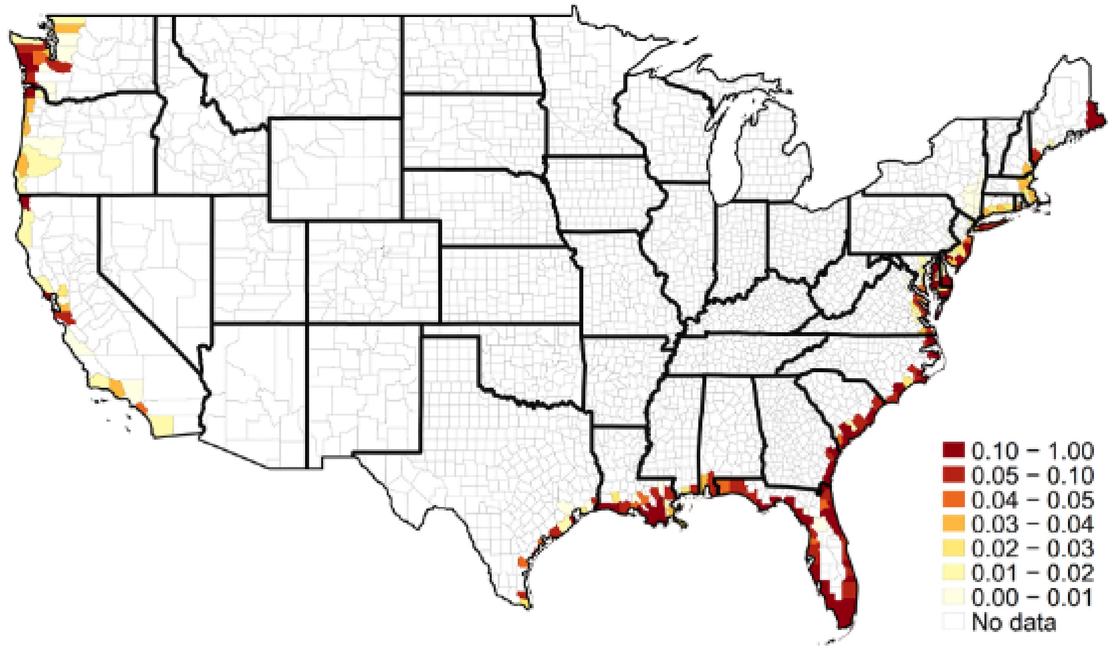
The price of a house is the present value of the stream of profit: rental payments minus upkeep costs

If SLR reduces future demand for rentals (decreases rental payments) or increases upkeep costs (e.g. more maintenance of the house), future rental profit goes down

Similar to annuities, this should decrease the price of the house

Sea level rise: where is it happening?

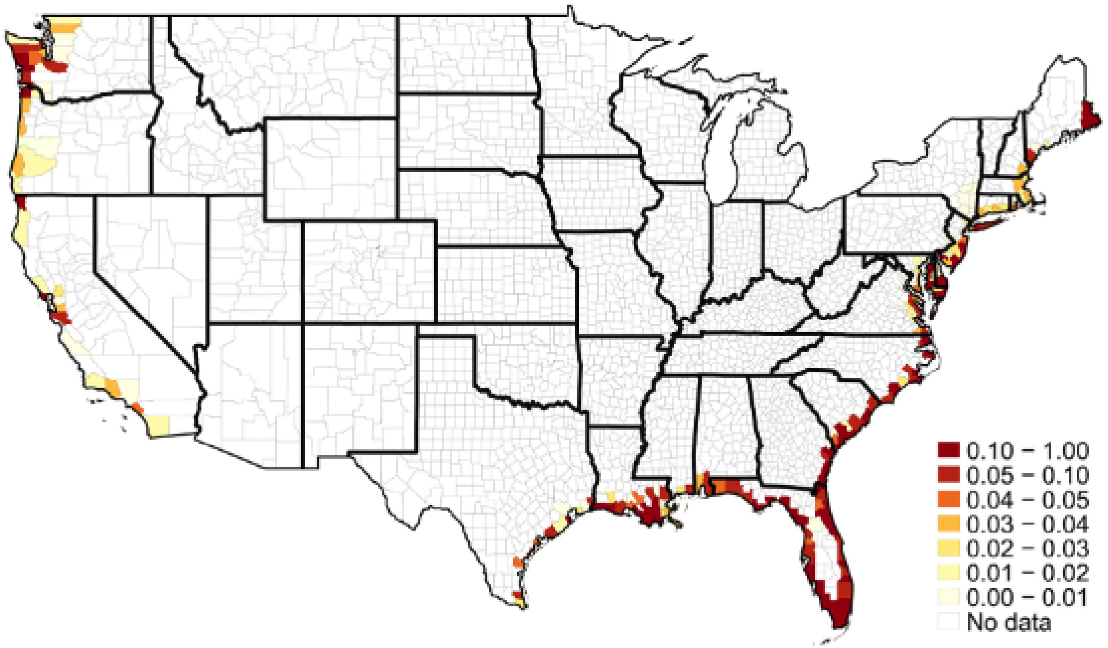
The map shows the share of houses sold between 2007-2017 that would be flooded with 6 feet of SLR



Sea level rise: where is it happening?

The map shows the share of houses sold between 2007-2017 that would be flooded with 6 feet of SLR

Lots of houses in the Southeast are exposed!



Sea level rise and housing prices

Bernstein, Gustafson, and Lewis (BGL) (2019) estimate how expected SLR affects current housing prices

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How do they do it?

Use a regression model to compare houses exposed to different amounts of SLR, but controlling for (i.e. have the exact same):

- Distance to the coast
- Zipcode
- Property characteristics (bedrooms, bathrooms, square footage, etc)
- Month of sale

Sea level rise: where is it happening?

BGL are *basically* computing the difference in house prices between two houses that are identical, in the same place, but one happened to be at higher elevation

This zipcode is only 92 square miles, and between 3 and 20 feet of elevation

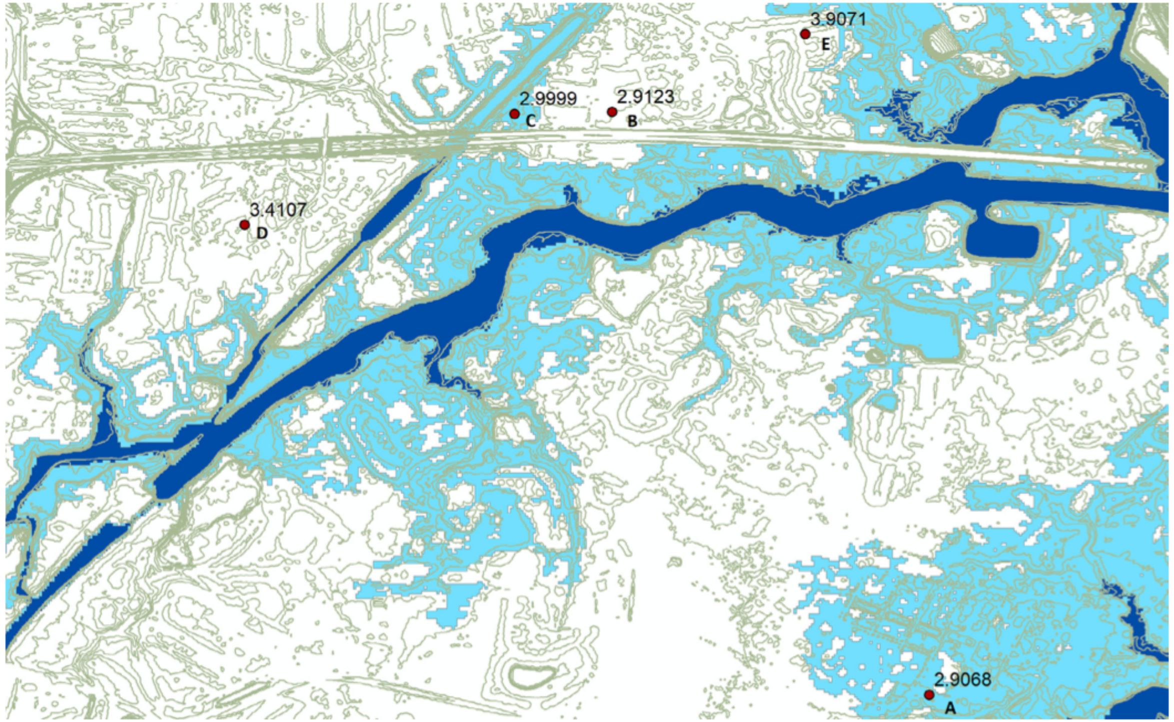
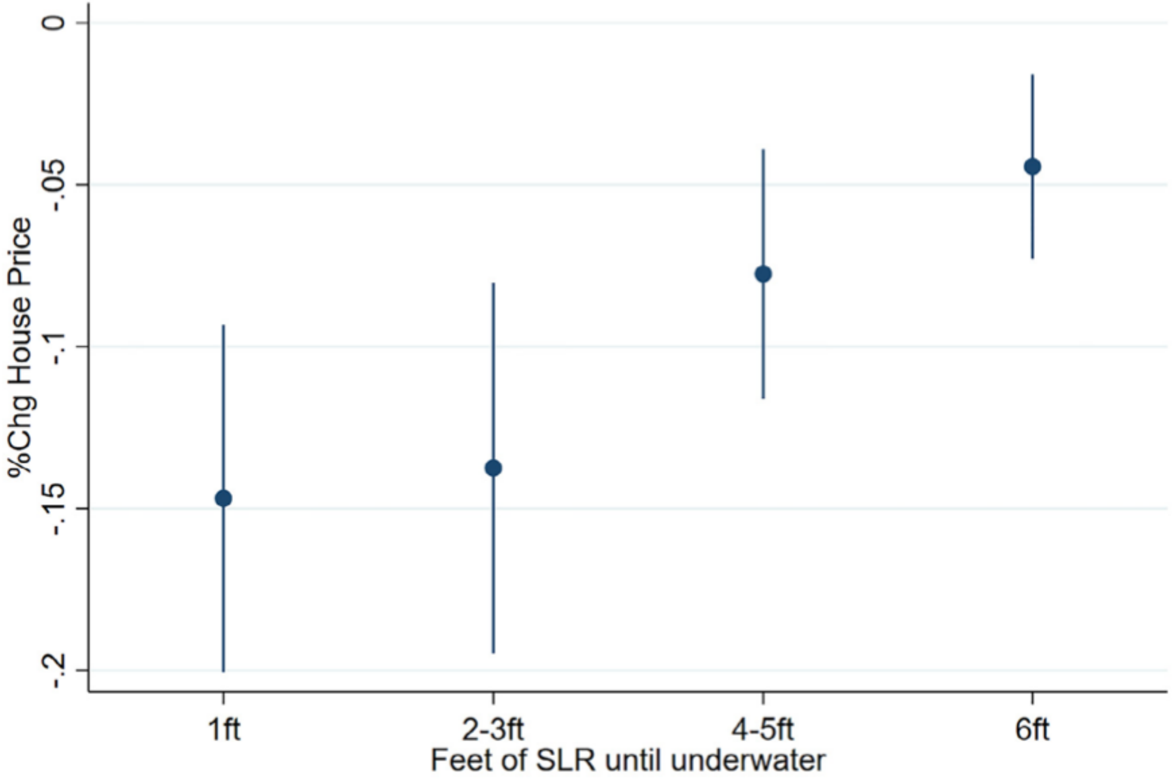


Fig. 2. Example of within-bin variation in SLR exposure. Fig. 2 displays five transactions in zip code 23323 (in Chesapeake, VA) during July of 2014, each of which involves a property that is (1) between 0.16 and 0.25 miles from the coast, (2) elevated between two and four meters above sea level, (3) four bedrooms, (4) a non-condominium, (5) owner occupied, (6) bought by a non-local buyer. Properties are labeled A–E, with elevation in meters above the property label. The olive contour lines represent 2-foot elevation contours. The dark blue area is the NOAA zero-foot SLR layer indicating the point of the highest high tide today while the light blue is the 6-foot layer indicating the highest high tide after six feet of global average sea level rise.

Sea level rise: what is the effect?

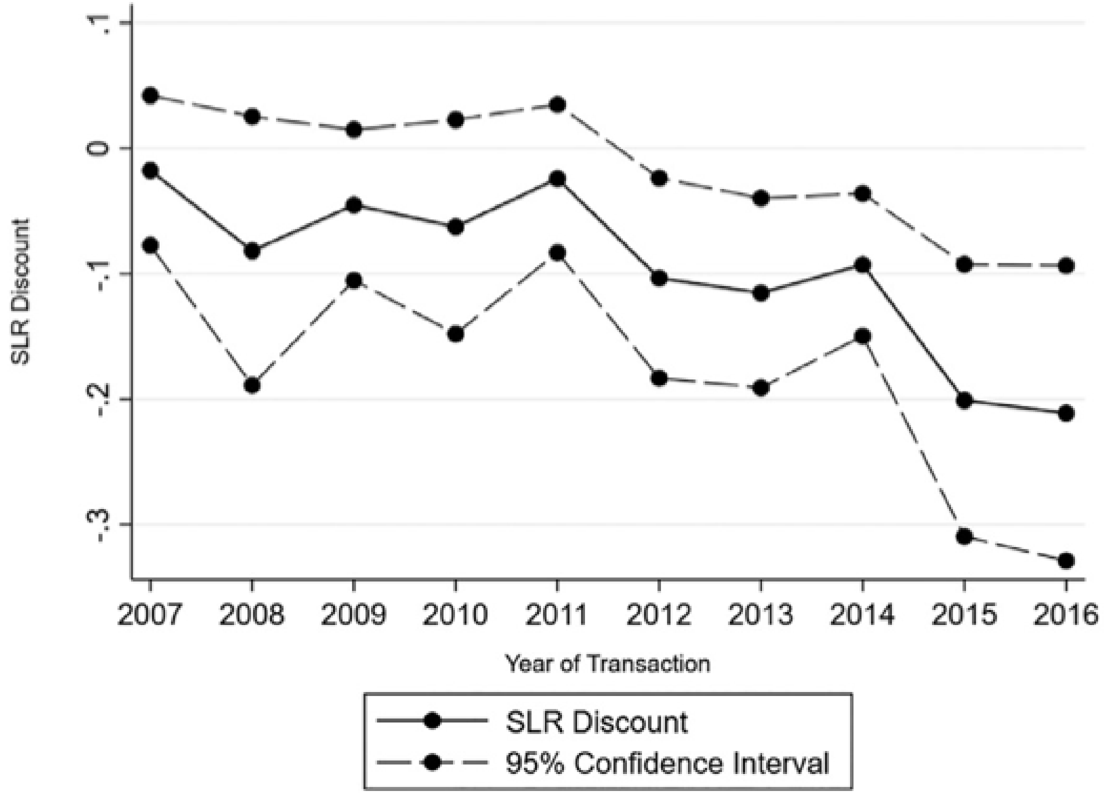
Houses that would be under water with 1 foot of SLR sell **15 percent** cheaper than the exact same house that is not SLR-exposed

The discount for houses exposed to 6 feet of SLR is only 5%



Sea level rise: what is the effect?

The discount from SLR (>6 feet) is getting **bigger** over time



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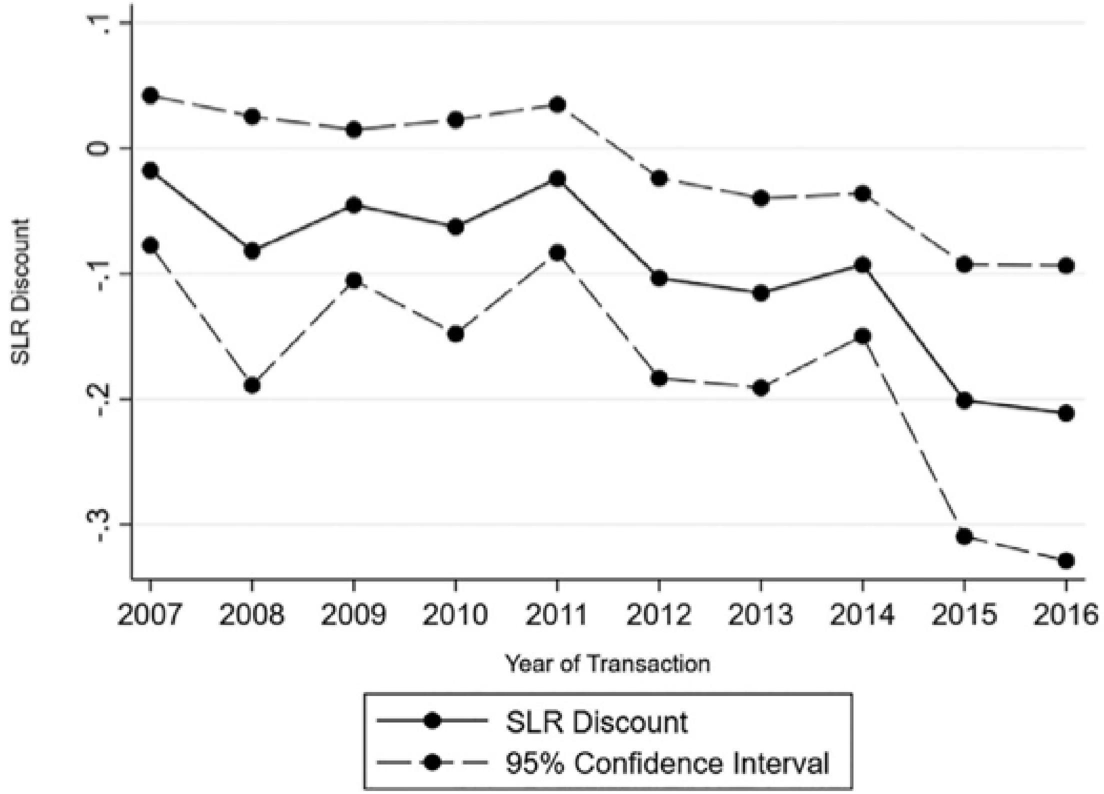

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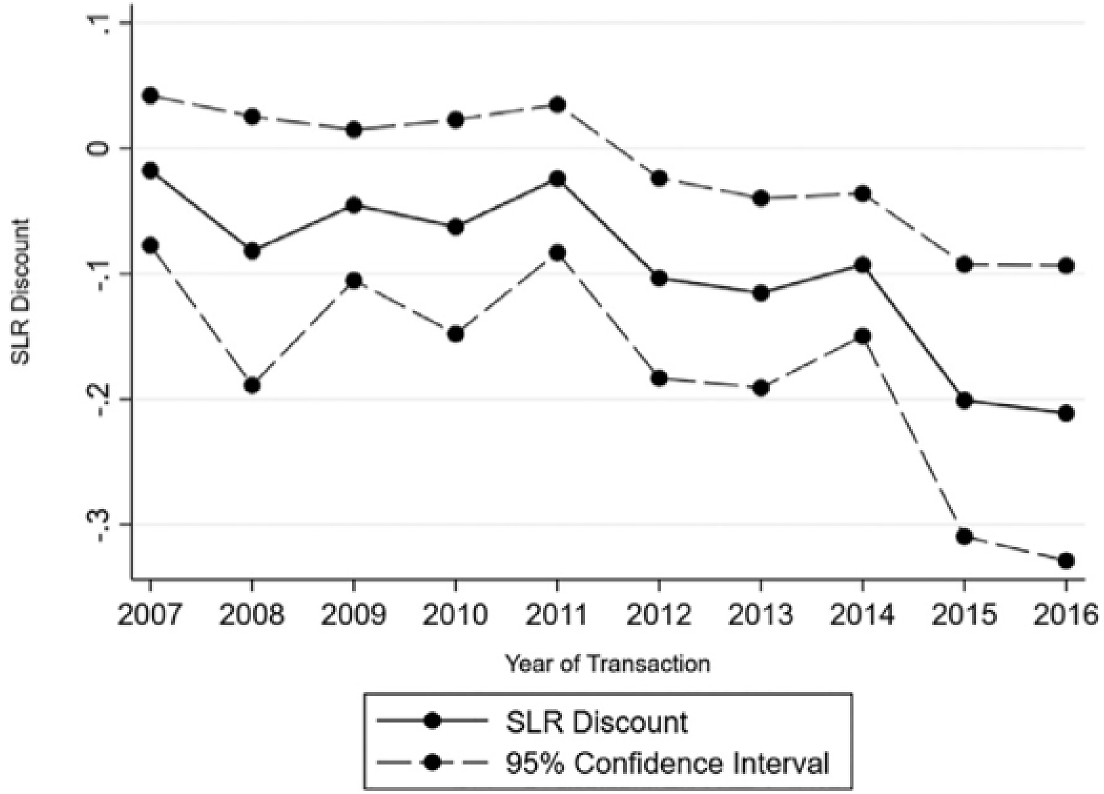
SLR projections may be updated over time and more dire



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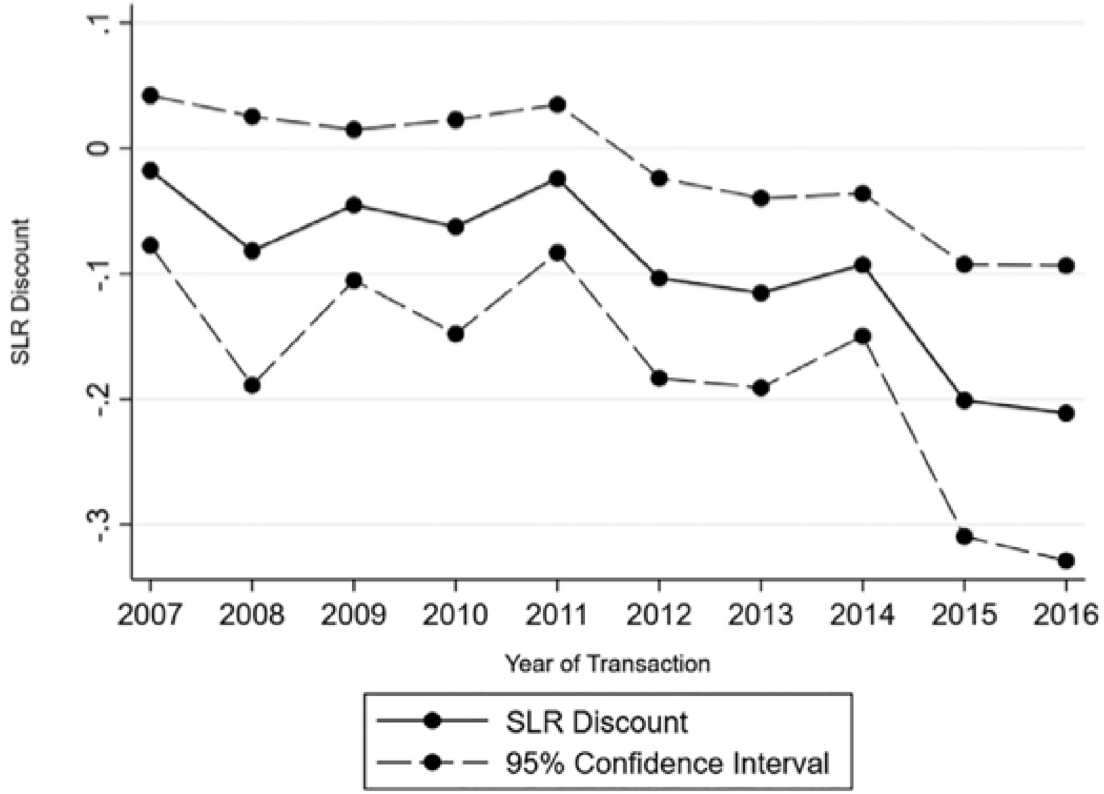
Buyers may be becoming more informed about SLR



Sea level rise: what about rents?

SLR isn't happening until far into the future so it shouldn't affect rents **today**

ln(price/sqft)	ln(price)
(3)	(4)
−0.003	−0.014

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−0.003	−0.014

BGL estimate how future SLR affects current rents and finds very small effects like we'd expect: discounts of 1.4% or smaller

Value of a statistical life (VSL)

How much should society spend, at the margin, to save a 'statistical life'?

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A statistical life is a probabilistic concept

VSL reflects willingness to pay for a reduction in the risk of death

VSL is more appropriately called the **value of mortality risk**

Value of a statistical life (VSL)

How do you get a credible estimate of the VSL?

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How?

See tradeoffs people make between cost and safety

Value of a statistical life (VSL)

Some examples:

Value of a statistical life (VSL)

Some examples:

Driving speed

Value of a statistical life (VSL)

Some examples:

Driving speed

Vehicle choice

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Wage-risk relationship

Value of a statistical life (VSL)

Some examples:

Driving speed

Vehicle choice

Wage-risk relationship

There's lots of studies, and lots of different answers

VSL

> EPA recommends that the central estimate of $7.4 million ($2006), updated to the year of the analysis, be used in all benefits analyses that seek to quantify mortality risk reduction benefits regardless of the age, income, or other population characteristics of the affected population until revised guidance becomes available

VSL thought experiment

Suppose that individuals are willing to adopt a safety procedure, for which they have to give up 25 cents per hour, to reduce risk of on-the-job fatality by 1 in 10,000 (annual risk)

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This procedure would result in one fewer person dying on average

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VSL = $500*10,000 = 5 million dollars

Estimating a hedonic wage function

We can estimate a **hedonic wage function:**

$$w_i = \alpha + \beta_1 H_i + \beta_2 X_i + \gamma_1 p_i + \gamma_2 q_i + \gamma_3 WC_i + \varepsilon_i$$

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w: wage

H: worker personal characteristics

X: job characteristics

p: **risk of death at the job**

q: non-fatal risk at the job

WC: workers' compensation benefits for injury

$\frac{\partial w}{\partial p}$ is the wage-risk trade off for marginal changes in risk

VSL from the hedonic wage function

Suppose:

- Wages were in thousands of dollars
- Risk is deaths per 10,000 people
- Coefficient on mortality risk p is $\gamma_1 = 0.4$

VSL from the hedonic wage function

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This implies an average WTP (reduced wage) of

VSL from the hedonic wage function

Suppose:

- Wages were in thousands of dollars
- Risk is deaths per 10,000 people
- Coefficient on mortality risk p is $\gamma_1 = 0.4$

This implies an average WTP (reduced wage) of 400 dollars to reduce risk by 1 in 10,000

VSL from the hedonic wage function

WTP (reduced wage) of 400 dollars to reduce risk by 1/10,000

VSL from the hedonic wage function

WTP (reduced wage) of 400 dollars to reduce risk by 1/10,000

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$$VSL = \underbrace{(0.4 \times 1000)}_{\substack{\text{WTP to reduce} \\ \text{risk by 1 in 10000}}} \times 10,000) = 4 \text{ million dollars}$$

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Suppose a policy reduces mortality risk by 1/10,000 for 60,000 people (saves 6 lives on average)

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Suppose a policy reduces mortality risk by 1/10,000 for 60,000 people (saves 6 lives on average)

This policy has a value of:

$$400 * 60,000 = 24 \text{ million dollars}$$

VSL estimates

Exhibit 7-3 Value of Statistcal Life Estimates (mean values in 1997 dollars)

Study	Method	Value of Statistical Life
Kneisner and Leeth (1991 - U.S.)	Labor Market	$0.7 million
Smith and Gilbert (1984)	Labor Market	$0.8 million
Dillingham (1985)	Labor Market	$1.1 million
Butler (1983)	Labor Market	$1.3 million
Miller and Guria (1991)	Contingent Valuation	$1.5 million
Moore and Viscusi (1988)	Labor Market	$3.0 million
Viscusi, Magat and Huber (1991)	Contingent Valuation	$3.3 million
Marin and Psacharopoulos (1982)	Labor Market	$3.4 million
Gegax et al. (1985)	Contingent Valuation	$4.0 million
Kneisner and Leeth (1991 - Australia)	Labor Market	$4.0 million
Gerking, de Haan and Schulze (1988)	Contingent Valuation	$4.1 million
Cousineau, Lecroix and Girard (1988)	Labor Market	$4.4 million
Jones-Lee (1989)	Contingent Valuation	$4.6 million
Dillingham (1985)	Labor Market	$4.7 million
Viscusi (1978, 1979)	Labor Market	$5.0 million
R.S. Smith (1976)	Labor Market	$5.6 million
V.K. Smith (1976)	Labor Market	$5.7 million
Olson (1981)	Labor Market	$6.3 million
Viscusi (1981)	Labor Market	$7.9 million
R.S. Smith (1974)	Labor Market	$8.7 million
Moore and Viscusi (1988)	Labor Market	$8.8 million
Kneisner and Leeth (1991 - Japan)	Labor Market	$9.2 million
Herzog and Schlottman (1987)	Labor Market	$11.0 million
Leigh and Folsom (1984)	Labor Market	$11.7 million
Leigh (1987)	Labor Market	$12.6 million
Garen (1988)	Labor Market	$16.3 million
Derived from EPA (1997) and Viscusi (1992).		