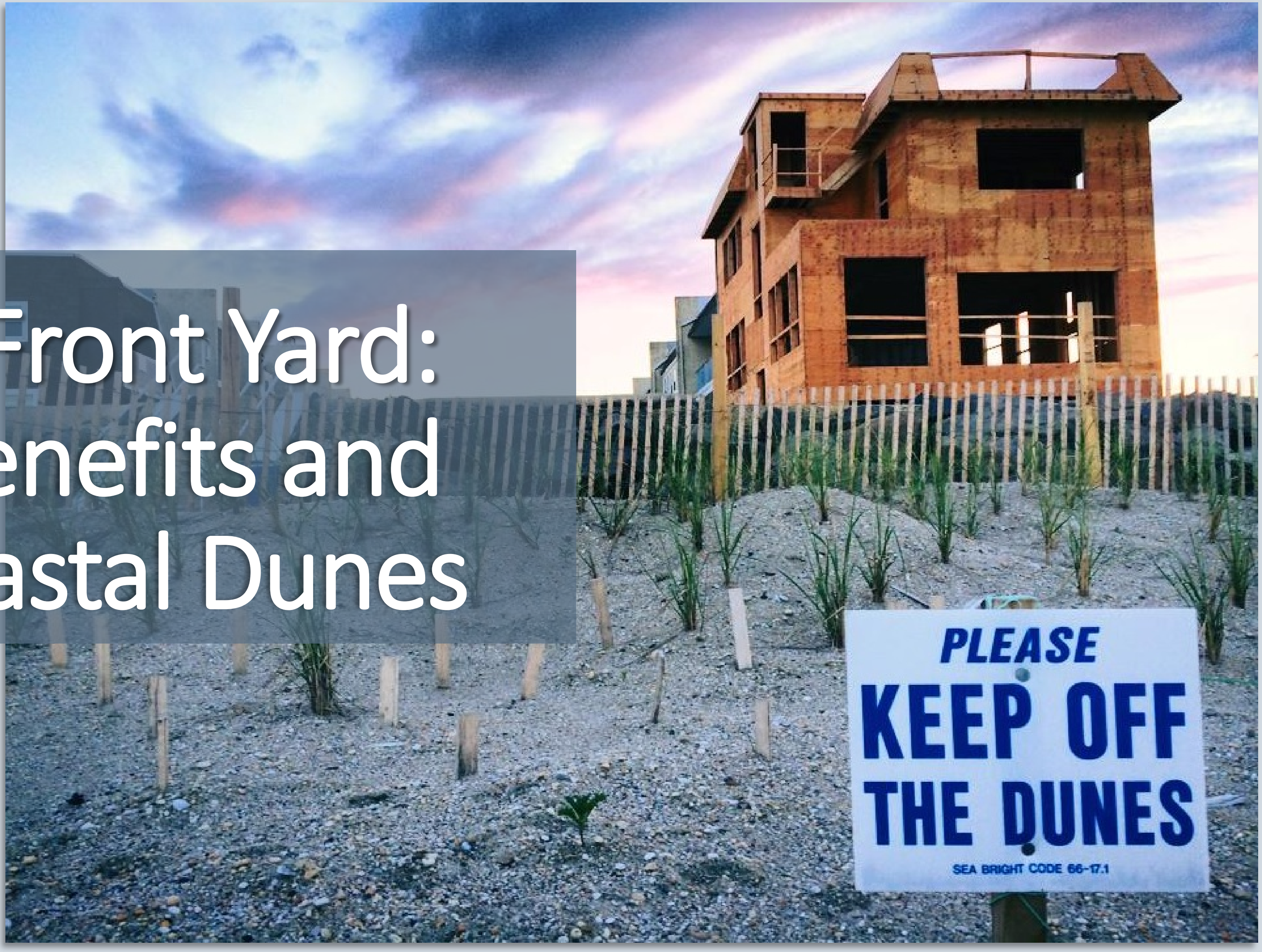
Not in My Front Yard: Amenity Benefits and Costs of Coastal Dunes



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NC STATE UNIVERSITY

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Overview

Evaluation of USACE coastline stabilization policies pre-Sandy

Hedonic model with quasi-experimental research design

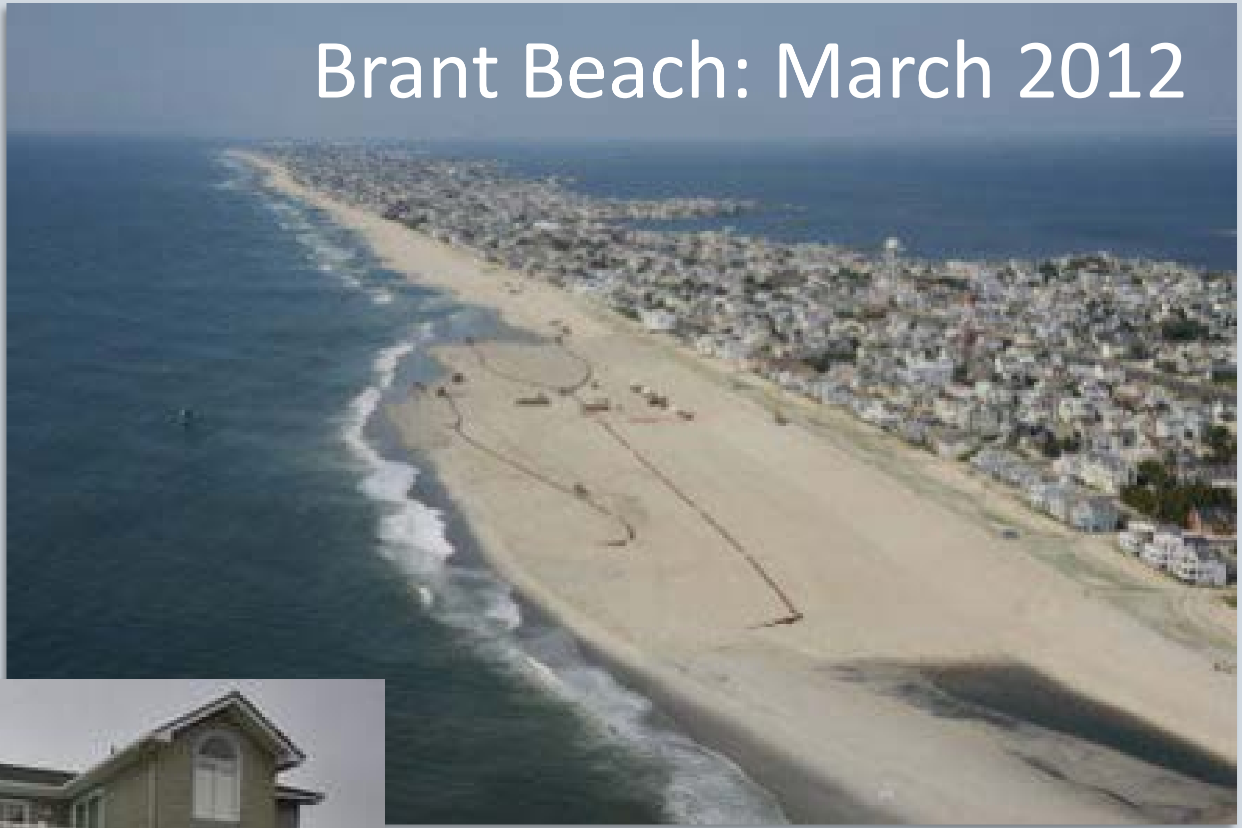
Main result: 3.6 % capitalization effect

Non-monotonic spatial impacts

Decomposition of amenity streams

Immediate legal and policy implications

Surf City:
January 2007



Brant Beach: March 2012

Holgate (LBT):
November 2009

Before and After SANDY Images

Before and After SANDY Images

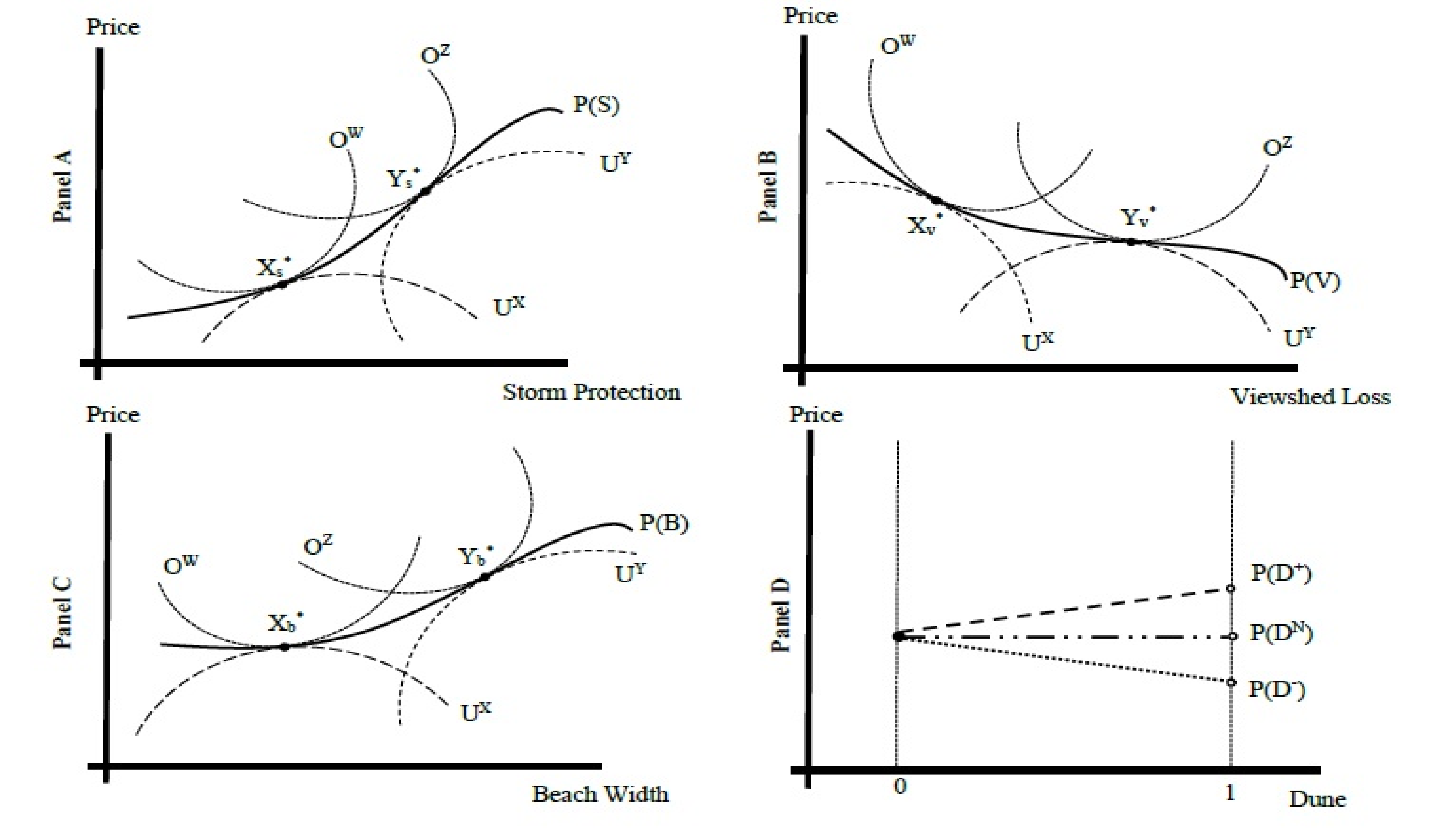
Hedonic Method in Coastal Markets

Follows Lancaster (1966) and Rosen (1974)

Barrier islands confound the effects of multiple amenities and hazards

- *Beach width (Landry & Hinsley 2011; Gopalakrishnan et al. 2011)*
- *Flood risk (Bin & Polasky 2004; Hallstrom and Smith 2005; Bin and Kruse 2006)*
- *Attempts to Decompose: Bin et al. (2008a, 2008b)*

Decompose the price impact of the dune into three impact streams: storm protection, viewshed loss, and beach width


Price
Panel A
O^Z
O^W
P(S)
U^Y
Y_s^*
X_s^*
U^X
Storm Protection
Price
Panel B
O^W
O^Z
X_v^*
Y_v^*
P(V)
U^X
U^Y
Viewshed Loss
Price
Panel C
O^W
O^Z
Y_b^*
P(B)
U^Y
X_b^*
U^X
Beach Width
Price
Panel D
$P(D^+)$
$P(D^N)$
$P(D^-)$
0
1
Dune

Policy Setting

Long Beach Island

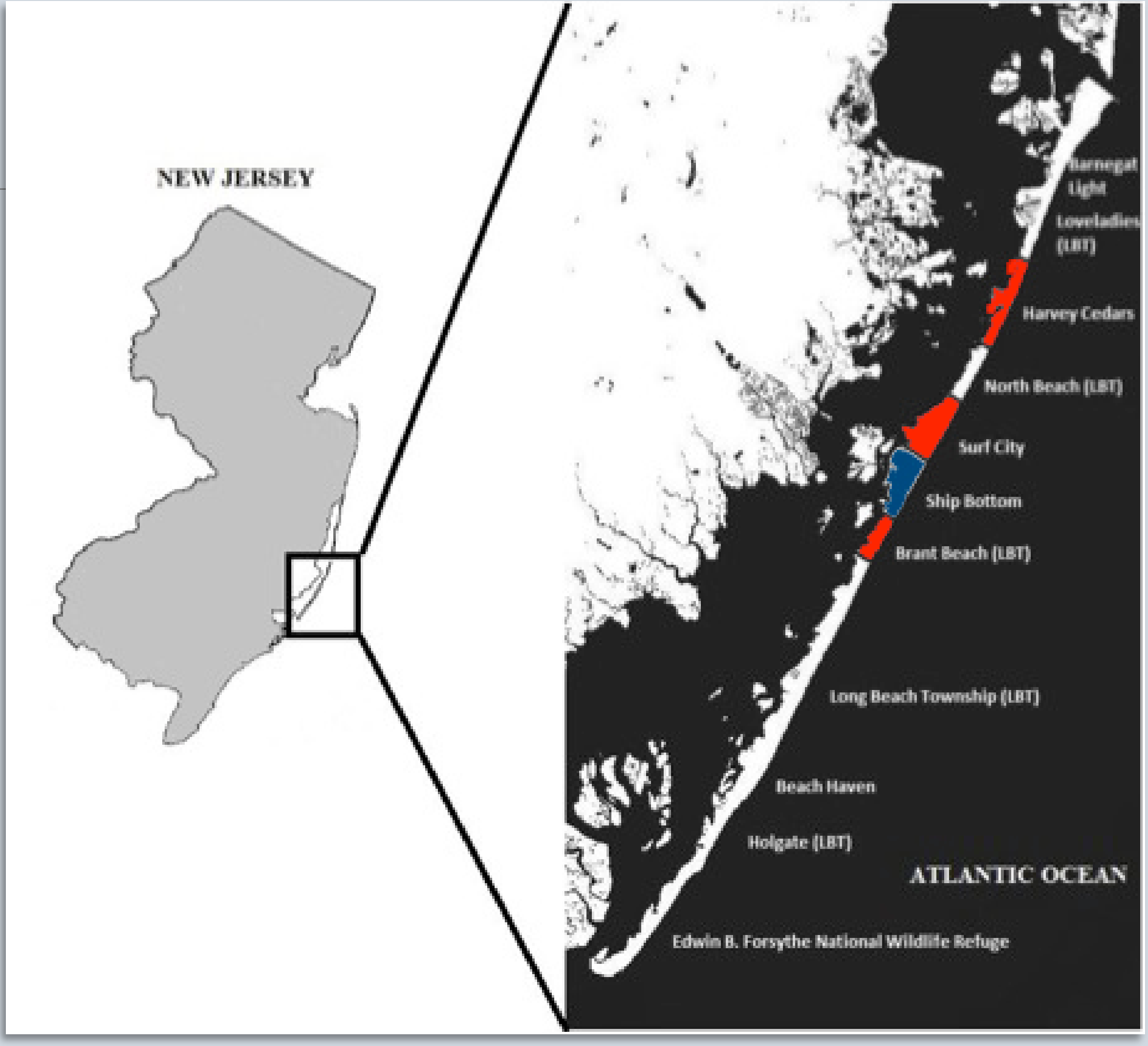
18-mile Barrier Island

Unchecked Coastal Development

Led to substantial erosion

Deficient Natural Dune System

Susceptible to massive failure



Policy Setting

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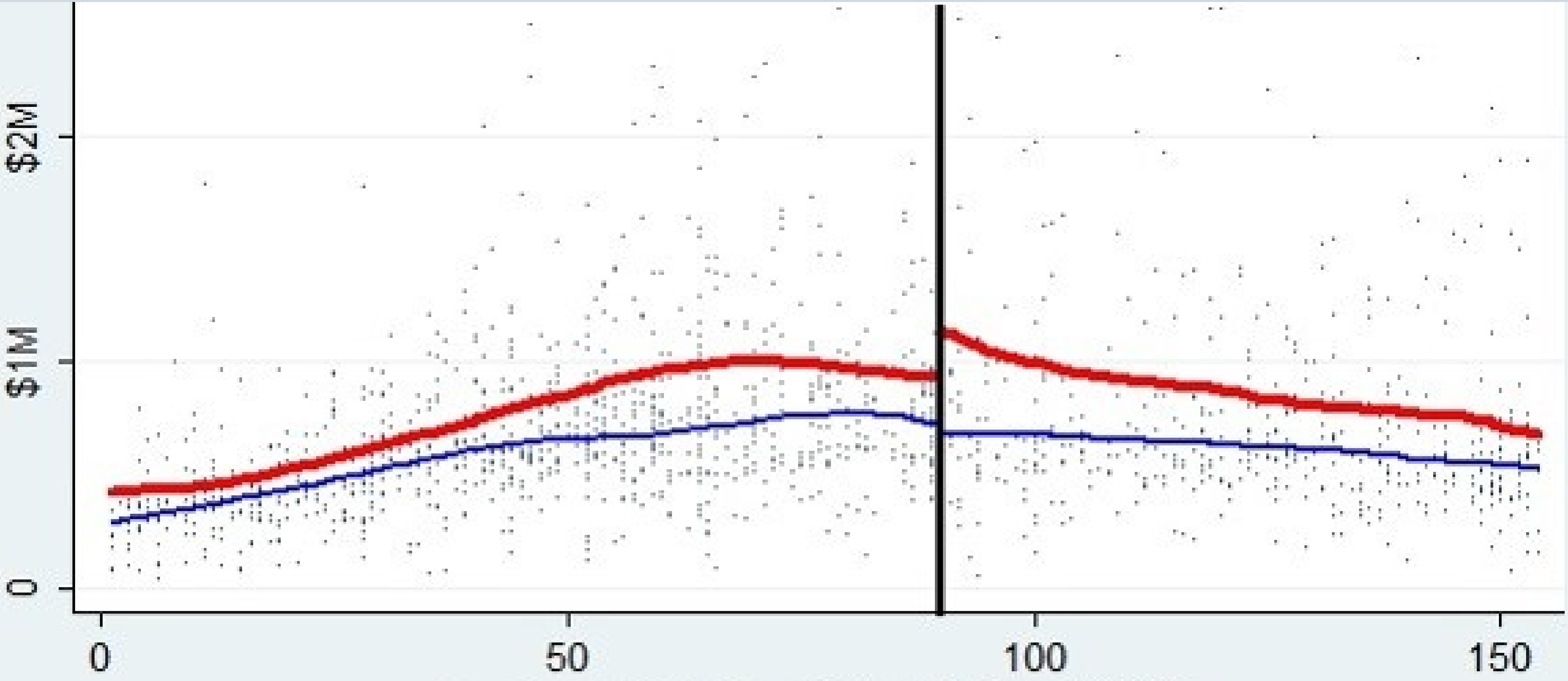
Housing Prices 2000-2012: Surf City v. Ship Bottom



Time in Months (1 = Jan. 2000, 154 = Oct. 2012)

Contentious Policy

Shift from hardened structures to “soft” dunes for storm protection

Voluntary easements required for projects to proceed

Oceanfront property owners cite amenity costs as justification for refusal

- Also concerned about the language in the perpetual easements

Not only LBI

- Fire Island, NY
- Absecon Island, NJ

Legal Conflict

New Jersey has laws protecting both sides of issue

- Public Trust Doctrine
- Vested Property Rights to ocean views, access, and breezes

Two core legal questions

- 1) How to secure land for the dunes with non-cooperative property owners?
- 2) How to interpret the benefits of the intervention for determining just compensation from the partial taking?

Borough of Harvey Cedars v. Karan

Data

Deed records and tax assessor reports

- Jan. 1. 2000 – Oct. 28, 2012
- 4,912 residential housing transactions
- Repeated cross-section

Merged transaction data with GIS parcel map

- Allows development of spatially explicit data set to improve identification

Variables

Housing Attributes

Distances to Landscape & Community Features

Fixed Effects

- Spatial Bin
- Neighborhoods
- NFIP Flood zones
- Time

Impacted Amenities

- Storm Protection
- Viewshed
- Beach Width

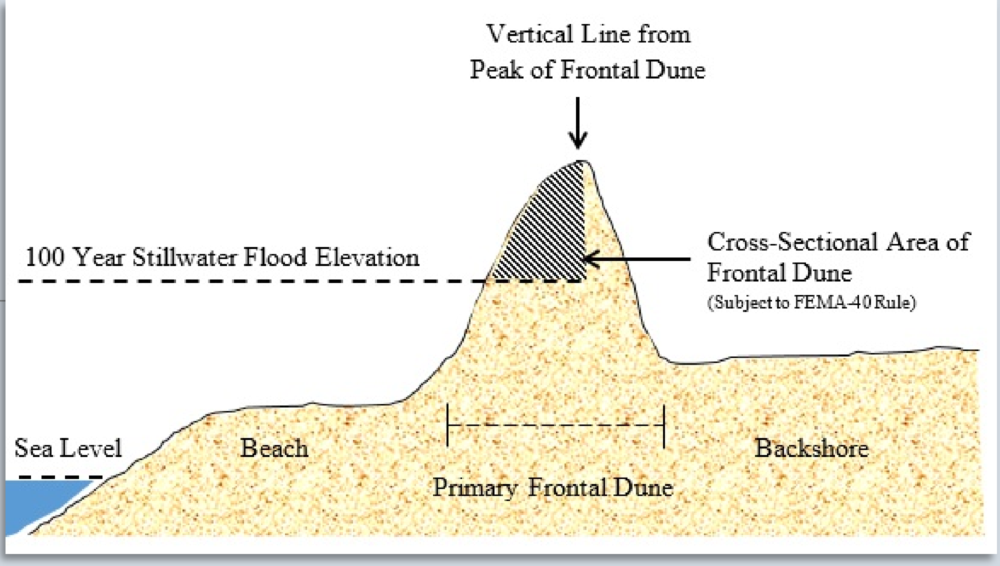
Summary Statistics

Housing Characteristics

	Mean	Std. Dev.	Min	Max
Sales Price (in 2012 dollars)	$942,344	$698,399	$46,667	$9,101,058
Bedrooms	3.79	1.18	1	10
Bathrooms	2.71	1.09	1	11
Square Footage	1746	796	195	18,000
Lot Size ($feet^2$)	5700	4915	0	86,249
Age	35.7	23	0	137

Storm Protection

Measured as a Level of Protection



1) Sand in cross-sectional area of frontal dune

2) Distance to discontinuity in the dune

		Frontal Dune Cross-Sectional Area	Distance to Dune Boundary (if *dune*=1)	Number of Parcels
Control Group	0	0 – 50	n/a	3,040
	1	51 – 100	n/a	1,249
	2	101 – 200	n/a	181
	3	201 – 300	n/a	0
	4	301 – 400	n/a	0
	5	401 - 500	n/a	0
Treated Group	6	540	0 – 500'	62
	7	540	501 – 1500'	107
	8	540	1501 – 2500'	135
	9	540	2501 – 3500'	92
	10	540	> 3500'	46

Viewshed Analysis

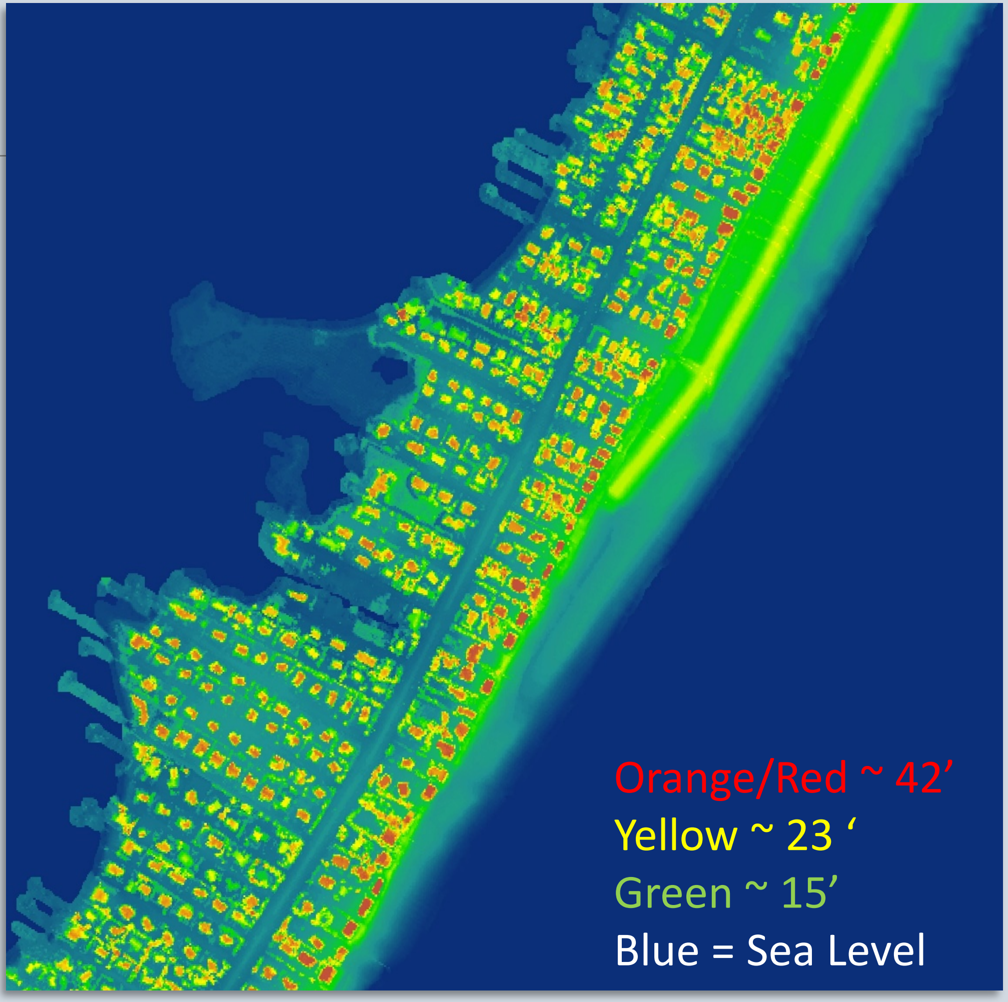
Not directly observable

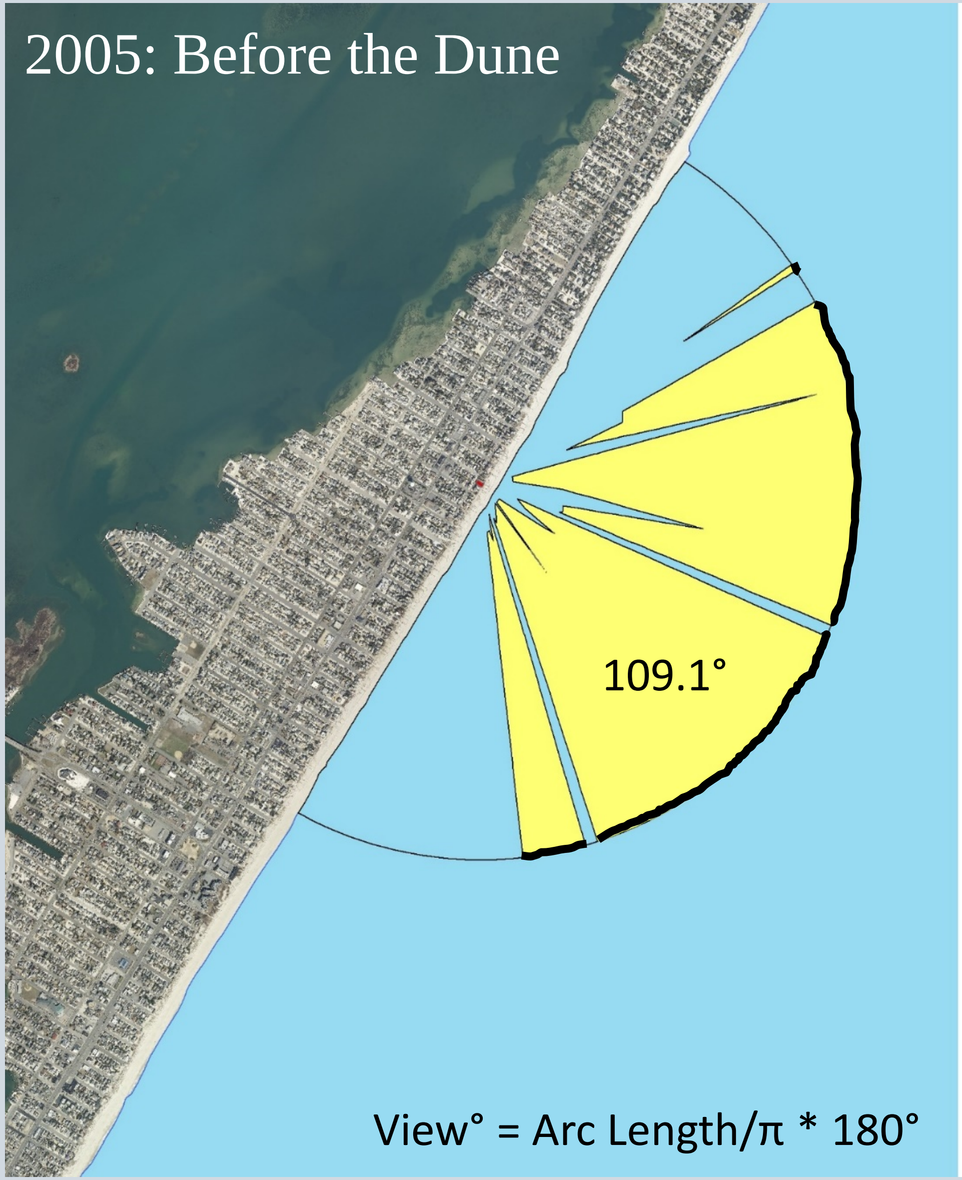
LiDAR data

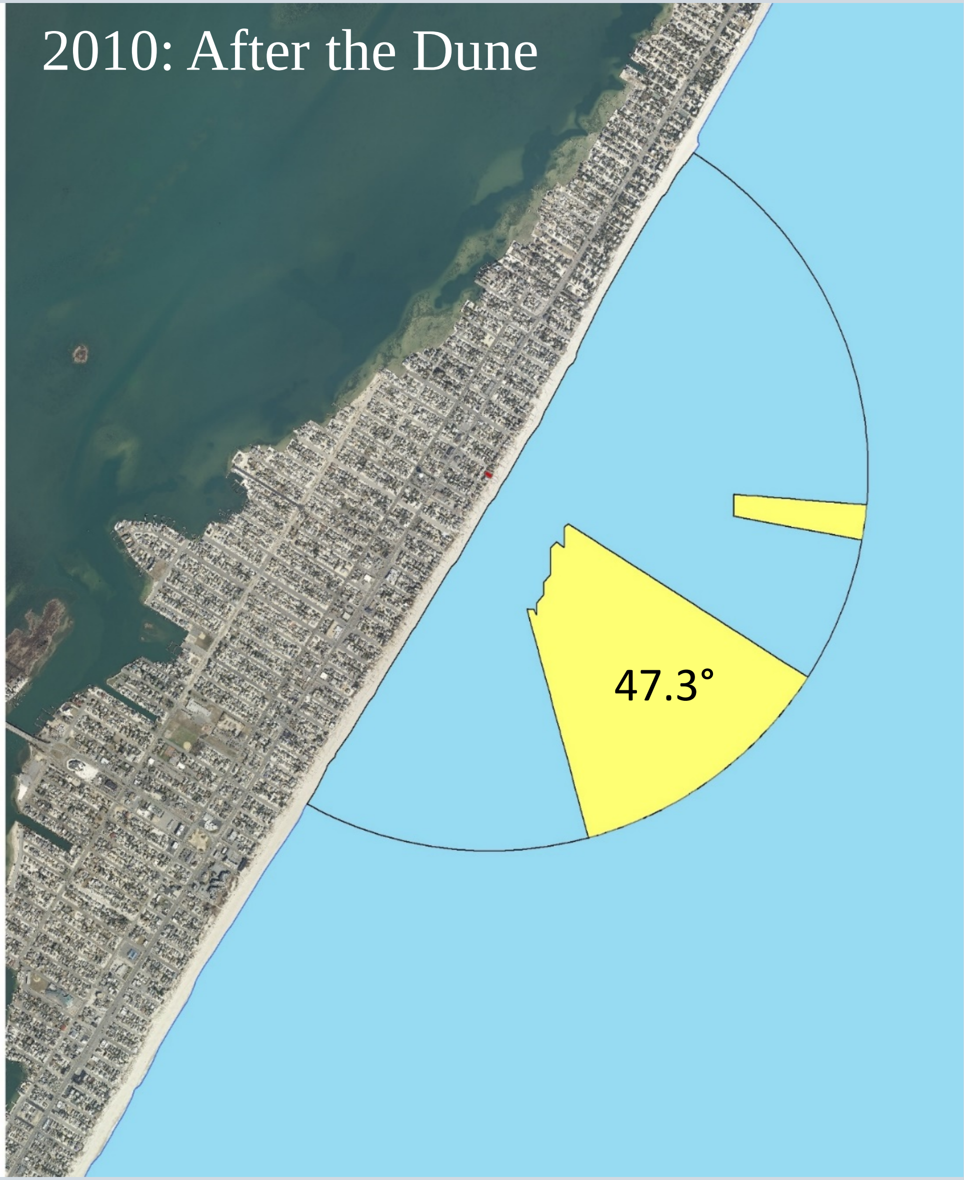
- 2005 DEM for “pre-dune” viewshed
- 2010 DEM for “post-dune” viewshed

Iterative algorithm generates a ocean viewshed from observation points on the first and second floor of each home

- Similar methodology Bin et al. (2010) & Crawford et al. (2013)




2005: Before the Dune
109.1°
View° = Arc Length/π * 180°


2010: After the Dune
47.3°

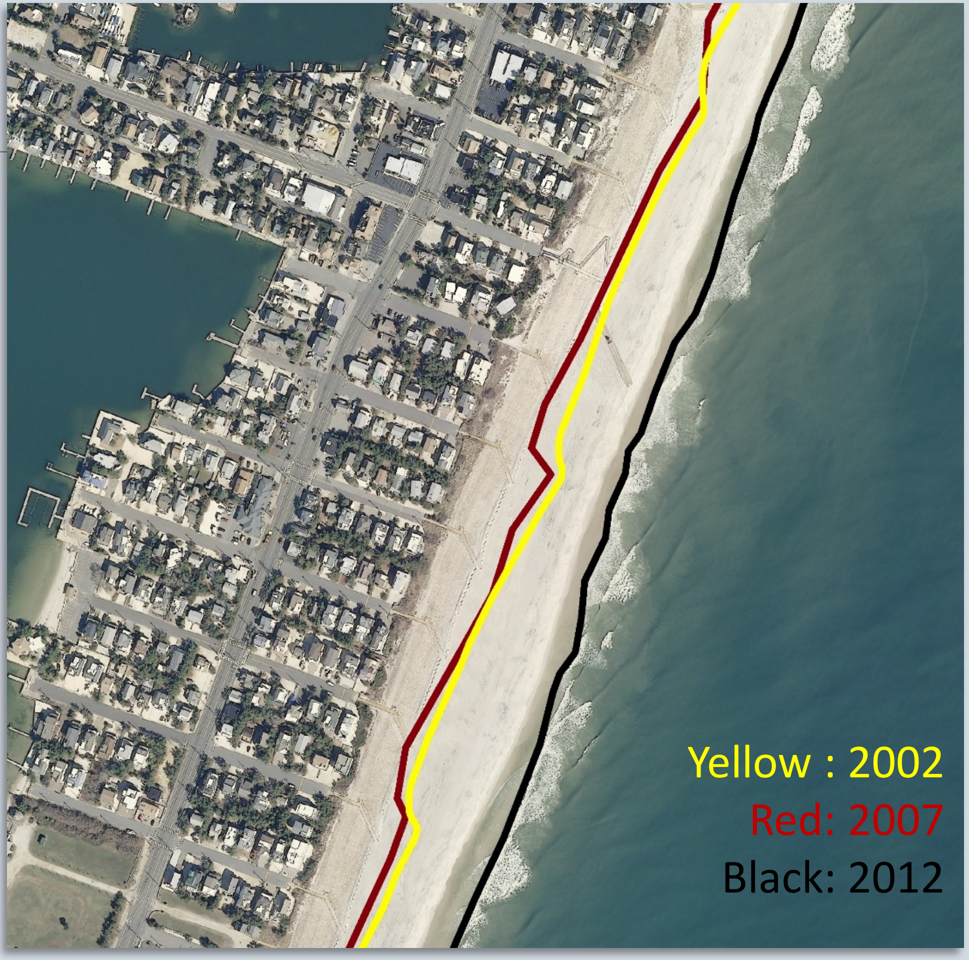
Beach Width

USACE dune project also added substantial (up to 200’) of beach berm

- Measured from parcels’ nearest point of access to shoreline

Atlantic shoreline shapefiles

- Assign 2000-2004 transactions 2002 beach width
- Assign 2005-2009 transaction 2007 beach width
- Assign 2010-2012 transaction 2012 beach width



Empirical Strategy

Treatment assigned after dune construction completed

- Transactions between awareness date & construction removed

Two plausible assumptions on treatment

- Exogeneity & Selection on Observables

Kline (2011)

- Oaxaca-Blinder decomposition robust to either assumptions
- Useful sample properties for unbalanced research designs with small treatment groups relative to the controls

Oaxaca-Blinder Decomposition

Model for potential outcomes

$$\text{Price}_i^d = X_i^{'}\beta^d + \varepsilon_i^d, \quad \mathrm{E}\left[\varepsilon_i^d \mid X_i, Dune_i\right] = 0 \qquad for\ d \in \{0,1\}$$

Difference the Expected Outcome Between the Treated and Control Group

$$E\left[Price_i^1 - Price_i^o\right] = E\left[\mathbf{X}_i \mid Dune_i = 1\right]' \cdot \beta^1 - E\left[\mathbf{X}_i \mid Dune_i = 0\right]' \cdot \beta^0$$

$$= E\left[\mathbf{X}_i \mid Dune_i = 1\right]' \cdot \beta^1 - E\left[\mathbf{X}_i \mid Dune_i = 0\right]' \cdot \beta^0 \boxed{+ E\left[\mathbf{X}_i \mid Dune_i = 1\right]' \cdot \beta^* - E\left[\mathbf{X}_i \mid Dune_i = 1\right]' \cdot \beta^*}$$

$$= E\left[\mathbf{X}_i \mid Dune_i = 1\right]' \cdot \left(\beta^1 - \beta^*\right) + \left(E\left[\mathbf{X}_i \mid Dune_i = 1\right]' - E\left[\mathbf{X}_i \mid Dune_i = 0\right]'\right) \cdot (\beta^* - \beta^0)$$

$$= \underbrace{E\left[Price_i^1 - Price_i^* \mid Dune_i = 1\right]}_{\text{Unexplained Component}} + \underbrace{\left(E\left[Price_i^* \mid Dune_i = 1\right] - E\left[Price_i^o \mid Dune_i = 0\right]\right)}_{\text{Explained Component}}$$

Unexplained Component
(Net effect of Treatment)

Explained Component
(Differences in Group Composition)

Oaxaca-Blinder Decomposition

Model for potential outcomes

$$\text{Price}_i^d = X_i^{'}\beta^d + \varepsilon_i^d, \quad \text{E}\left[\varepsilon_i^d \mid X_i, Dune_i\right] = 0 \qquad \textit{for } d \in \{0,1\}$$

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$$= E\left[\mathbf{X}_i \mid Dune_i = 1\right]' \cdot \beta^1 - E\left[\mathbf{X}_i \mid Dune_i = 0\right]' \cdot \beta^0 + E\left[\mathbf{X}_i \mid Dune_i = 1\right]' \cdot \beta^* - E\left[\mathbf{X}_i \mid Dune_i = 1\right]' \cdot \beta^*$$

$$= E\left[\mathbf{X}_i \mid Dune_i = 1\right]' \cdot \left(\beta^1 - \beta^*\right) + \left(E\left[\mathbf{X}_i \mid Dune_i = 1\right]' - E\left[\mathbf{X}_i \mid Dune_i = 0\right]'\right) \cdot (\beta^* - \beta^0)$$

$$= E\left[Price_i^1 - Price_i^* \mid Dune_i = 1\right] + \left(E\left[Price_i^* \mid Dune_i = 1\right] - E\left[Price_i^o \mid Dune_i = 0\right]\right)$$

Unexplained Component
(Net effect of Treatment)

Explained Component
(Differences in Group Composition)

Weighting Matrix

$$\beta^* = \mathbf{\Omega}\hat{\beta}^1 + (I - \mathbf{\Omega})\hat{\beta}^0$$

Weighting Options

Oaxaca (1973): $\boldsymbol{\Omega} = 0 \; or \; 1$

Reimers (1983): $\boldsymbol{\Omega} = 0.5I$

Cotton (1988): $\boldsymbol{\Omega} = sI$

Oaxaca and Ransom (1994): $\boldsymbol{\Omega} = (\mathbf{X}_1'\mathbf{X}_1 + \mathbf{X}_0'\mathbf{X}_0)^{-1}\mathbf{X}_1'\mathbf{X}_1$

Coefficients from a pooled model over both groups used as the reference coefficients.

Main Results

Oaxaca-Blinder [a]	*Naïve Model*	*Fixed Effects Only*	*Preferred Model*
Dune	0.0072	0.1058***	0.0356***
	(0.0122)	(0.0157)	(0.010)
Dune*Oceanfront	-0.0406	0.1221**	0.0430***
	(0.0549)	(0.0538)	(0.0159)
Dune*Oceanfront Block	0.0058	0.2205***	0.0659***
	(0.0186)	(0.0371)	(0.0143)
Dune*Second Block	-0.2241***	0.0657	0.0105
	(0.0421)	(0.0427)	(0.020)
Dune*Third Block	0.0003	0.1033***	0.0313**
	(0.0190)	(0.0205)	(0.0129)
Dune*Fourth Block	-0.0217	-0.0011	-0.0327
	(0.0345)	(0.0363)	(0.0253)
Dune*Bayfront	-0.0861	0.0138	-0.0360
	(0.0685)	(0.0977)	(0.0452)

Spatial Results

Oaxaca-Blinder [a]	*Naïve Model*	*Fixed Effects Only*	*Preferred Model*
Dune	0.0072 (0.0122)	0.1058*** (0.0157)	0.0356*** (0.010)
Dune*Oceanfront	-0.0406 (0.0549)	0.1221** (0.0538)	0.0430*** (0.0159)
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Dune*Fourth Block	-0.0217 (0.0345)	-0.0011 (0.0363)	-0.0327 (0.0253)
Dune*Bayfront	-0.0861 (0.0685)	0.0138 (0.0977)	-0.0360 (0.0452)

Robustness Checks

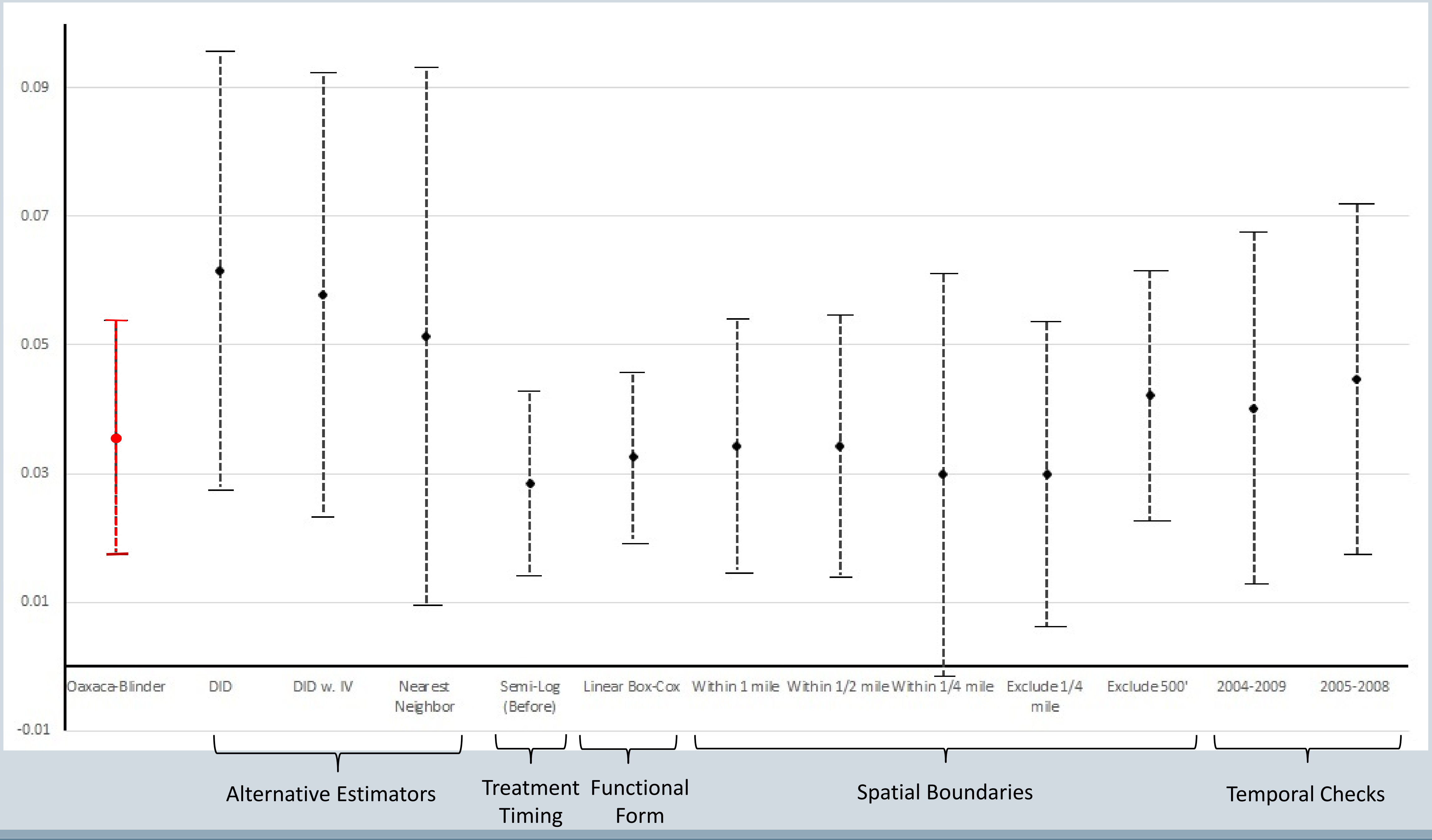
Alternative Estimators
- Difference-in-Differences
- Nearest Neighbor Matching

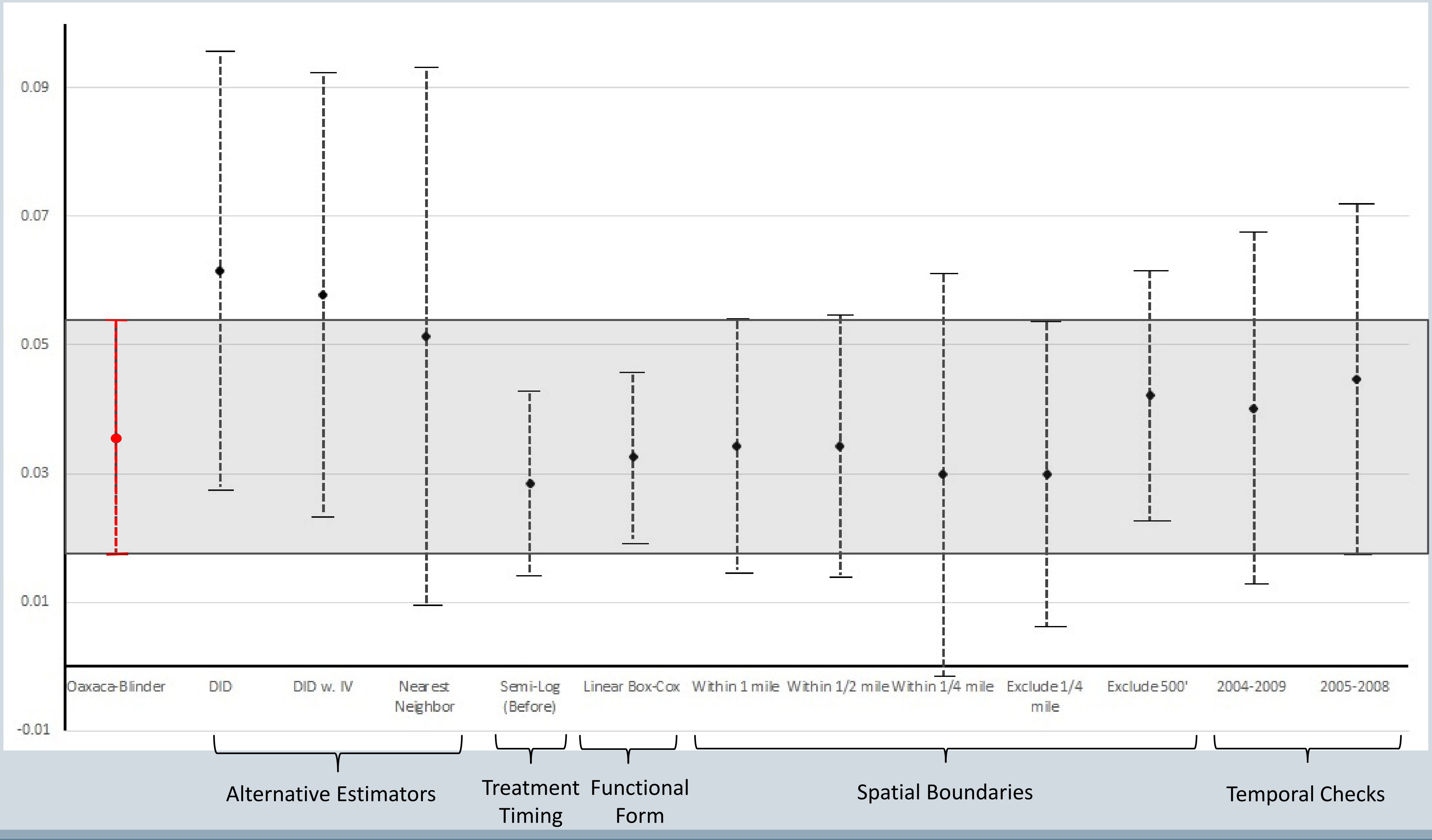
Functional Form for Hedonic Price Function
- Linear Box-Cox

Treatment Timings
- *Before* treatment

Spatial Boundaries
- Inclusion Models: Keep only sales within 1, ½ , and ¼ mile of dune discontinuity
- Exclusion Models: Drop sales within ¼ mile and 500 feet of dune discontinuity

Temporal Narrowing
- 2004-2009
- 2005-2008


0.09
0.07
0.05
0.03
0.01
-0.01
Oaxaca-Blinder
DID
DID w. IV
Nearest Neighbor
Semi-Log (Before)
Linear Box-Cox
Within 1 mile
Within 1/2 mile
Within 1/4 mile
Exclude 1/4 mile
Exclude 500'
2004-2009
2005-2008
Alternative Estimators
Treatment Timing
Functional Form
Spatial Boundaries
Temporal Checks


0.09
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Treatment Effect Decomposition

Decomposition of treatment effect of dune into amenity stream that are impacted: **Storm Protection, Ocean View, and Recreation/Access**

Using OLS, the estimation equation would take the following form:

$$lnPrice_{it} = \alpha + Protect_{it}[\delta_1 + \delta_2 Dune] + View_{it}[\gamma_1 + \gamma_2 Dune] + BW_{it}[\lambda_1 + \lambda_2 Dune] + \boldsymbol{X}_{it}\,\sigma + \boldsymbol{L}_{it}\,\rho + \tau_t + \eta_t + \epsilon_{it}$$

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Treatment Effect Decomposition

1(Dune)*Protect	0.0258**
1(Dune)*View	-0.0037**
1(Dune)*Beach Width	-0.0007***
Spatial Bin FE	X
Neighborhood FE	X
Time FE	X
Selected Characteristics	X
Distance Variables	X
Observations	4827
R-Squared	0.7011

Treatment Effect Decomposition

1(Dune)*BeachWidth*OF	-0.0021**
1(Dune)*BeachWidth*OFB	-0.0002
1(Dune)*BeachWidth*2	-0.0004
1(Dune)*BeachWidth*3	-0.0004
1(Dune)*BeachWidth*4	-0.0007
1(Dune)*BeachWidth*BF	-0.0014
R-Squared	0.7032

1(Dune)*Protect	0.0258**
1(Dune)*View	-0.0037**
1(Dune)*Beach Width	-0.0007***
Spatial Bin FE	X
Neighborhood FE	X
Time FE	X
Selected Characteristics	X
Distance Variables	X
Observations	4827
R-Squared	0.7011

Policy Implications

Immediate: Justifies use of specific benefits in just compensation decisions and provides method to quantify these benefits

Benefit-Cost analysis

- $600 million capitalization in LBI housing market
- $261 million in engineering costs for projects to date
  - Protects only 4.3 miles of the island

Perspective of Federal Government

- Reduces liability (NFIP and FEMA disaster aid)

Distributional Concerns

Conclusion

Shoreline stabilization as a climate adaptation strategy

Characterization of the interactions associated with adaptation

- Economic Market
- Non-market Services
- Political Economy

Adaptations are complex

Behavior of economic agents complement or inhibit public interventions

Thank You!

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