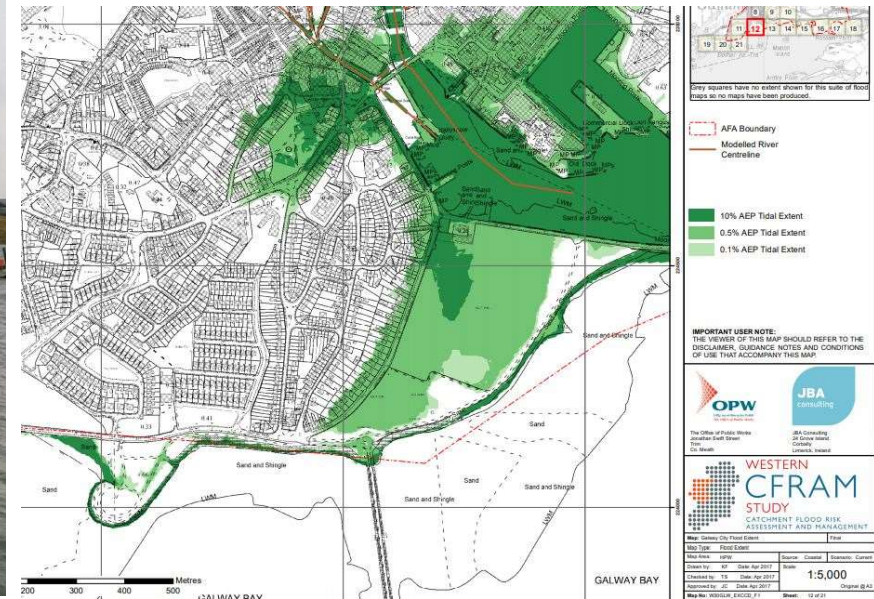


The Effects of Flood Risk on the Irish Housing Market

Tom Gillespie (NUIG)
Thomas McDermott (NUIG)
Ronan Lyons (TCD)



Overview

- We ask: Does flood risk affect house prices?
- Expect a negative discount – flood risk as a disamenity
- But identification problems – risk overlaps with (positive) amenities – advantage of having sea view measure
- Also, low salience/low risk perceptions
 - People may be badly informed (lack good information on flood risk)
 - Moral hazard argument – taxpayers bear (some of) the costs (Kydland and Prescott's Nobel Prize winning contribution, 1978)
 - The market signal may be weak
 - As a result there is a tendency towards **over-exposure** to flood risk
- We exploit rich official data on flood risk, events, and defences:
 - Countrywide maps of 1-in-1000-year, 1-in-100-year, and 1-in-10 year coastal and fluvial flood risk
 - 1,947 flood events (points and polygon data)
 - 68 flood defence schemes (polygons; dated and by type)

Overview 2: Why study flooding?

- Flood risk is one of the most pervasive natural risks
 - Flood risk is estimated to affect 15% of the world's population
 - One billion people in 155 countries are exposed to flood risk
 - (2017 JRC Atlas of the Human Planet)
- Floods are already costly
 - in past 30 years, floods worldwide killed >500,000 people and displaced >650,000,000 people
 - Worldwide costs of flooding in the tens of billions of US\$ per year
- Climate change & sea level rise increases flood risk, especially in coastal areas
- We examine how flood risk affects residential property values
 - Due to its immovable nature – and its prevalence in the typical household's balance sheet – residential property is at the core of understanding the potential economic effects of flood risk
- We do so by looking at the case of Ireland since 2006:
 - Recent floods in Ireland have been costly (~€1bn insured losses, 2000-2014)
 - Irish Gov has committed to spending €100s millions on flood relief schemes (existing 68 schemes, for which we have data, cost ~€226.6 million in total)
 - New risk information – CFRAMs project

Overview 3

- Identification rests ultimately on timing (and a rich set of controls):
 - Of flood events
 - Of the construction of flood defences
 - Of the release of flood risk information to the public

Results Preview

There are four main findings:

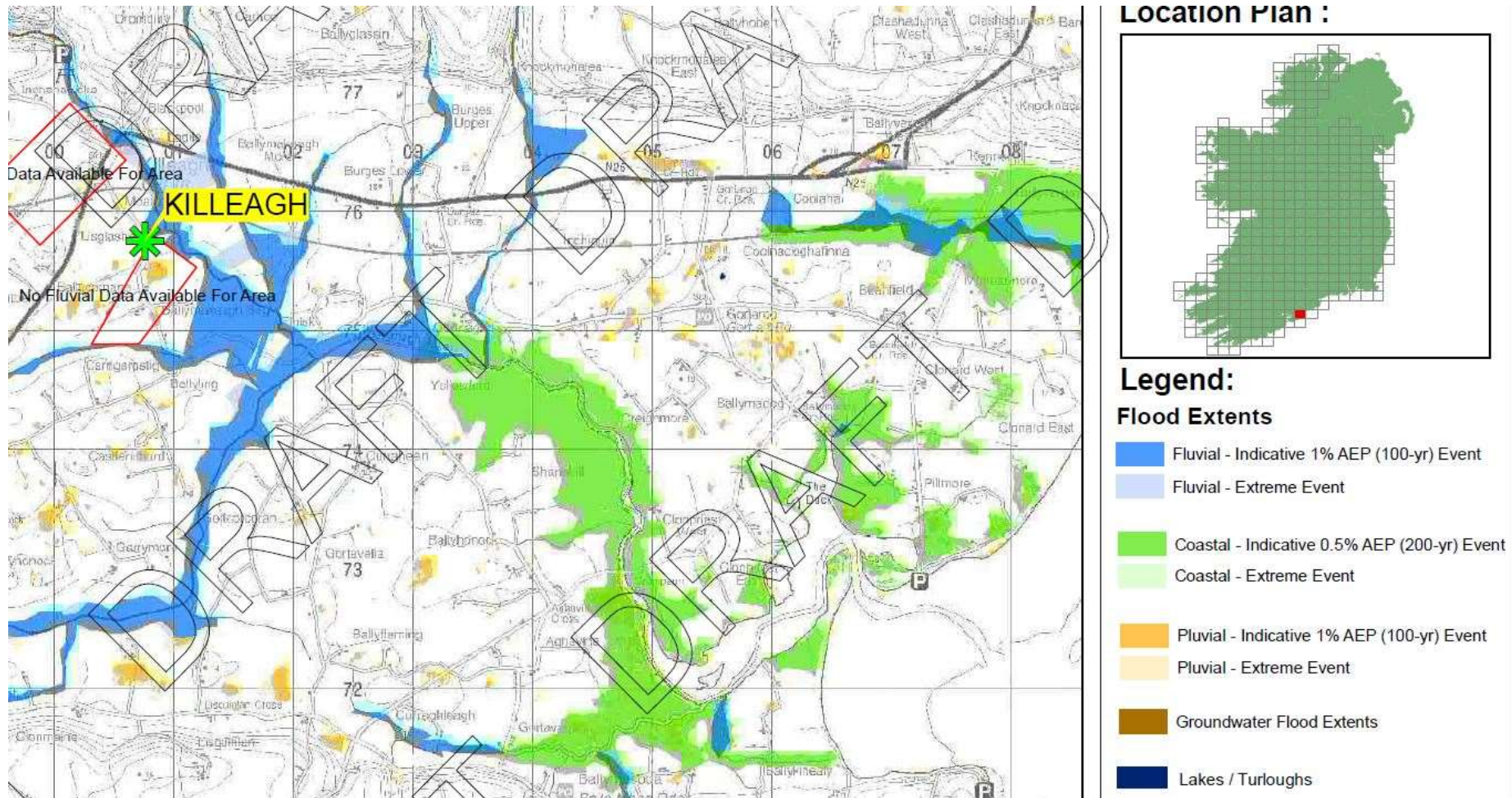
1. **Information matters** – prices responded dramatically to the release of flood risk maps in 2011, with the emergence of an 3.41% discount for a 1 in a 100 risk zone or higher
2. **Flood defences work**: the discount for flood risk is reversed into a premium (or disappears) after the construction of defences
3. **Flood risk is borne unequally**: properties in lowest decile of value suffer a ~8% discount, compared to no statistically significant one in the top decile
4. **The market's memory of flood events is short** – a 4.5% price discount for being within a flood event disappears after two years

Policy implications for flood risk management, insurance and flood defences, as well as for projections of future flood losses

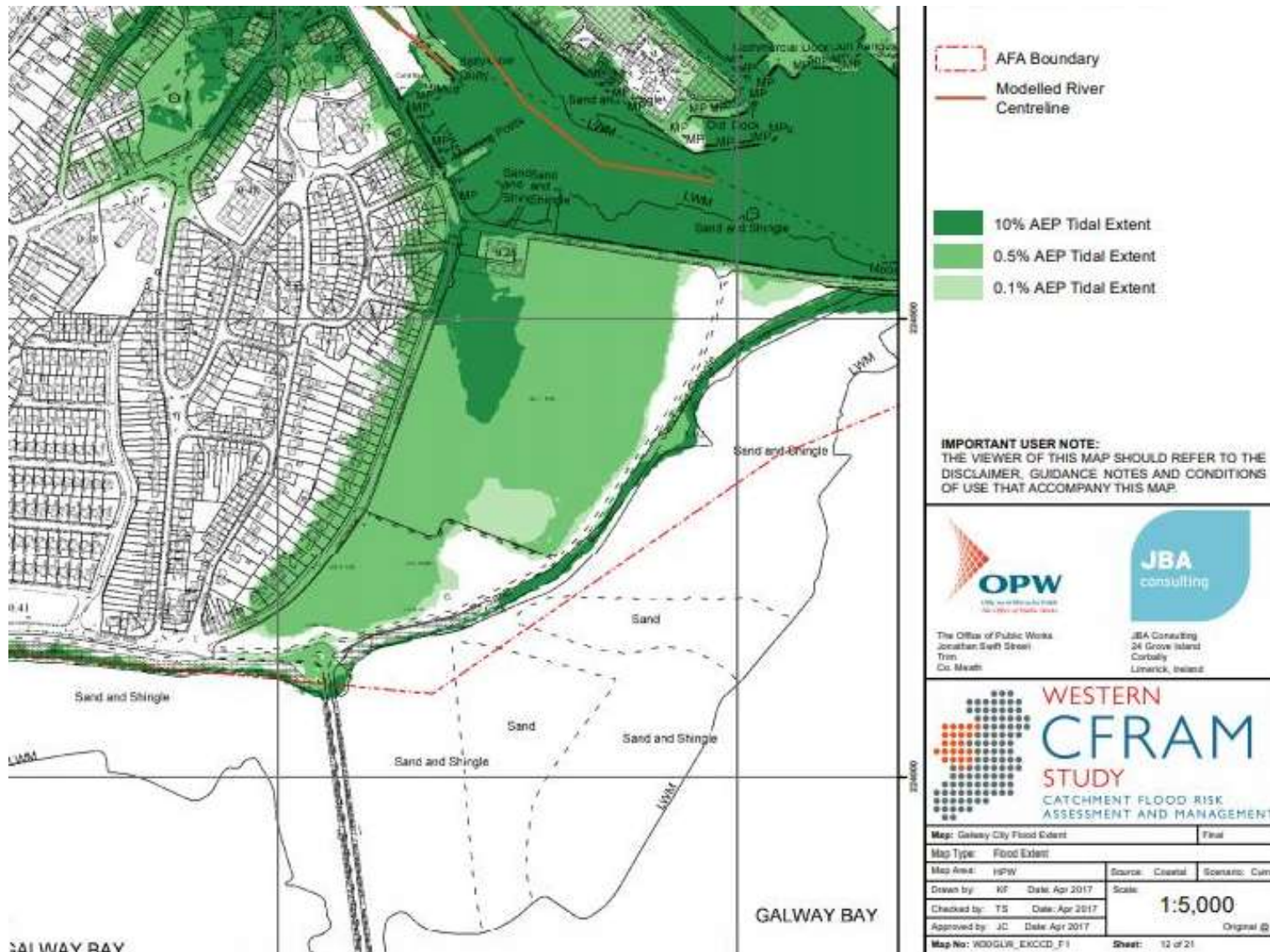
Real estate data comes from daft.ie

- Online listings for all of Ireland, from 2006 to 2018
- For every listing, rich dwelling information:
 - Date and listed price
 - Dwelling type and size (in bedrooms and bathrooms)
 - Additional information using text of the ad (e.g. “built-in wardrobes”, “patio”, “red brick”, “balcony”)
- Transactions sample
 - Combines Property Price Register – BER – Daft data, via Eircodes
 - Includes transacted price, BER data, high location accuracy
 - ~35k listings within greater Dublin area 2010-2018

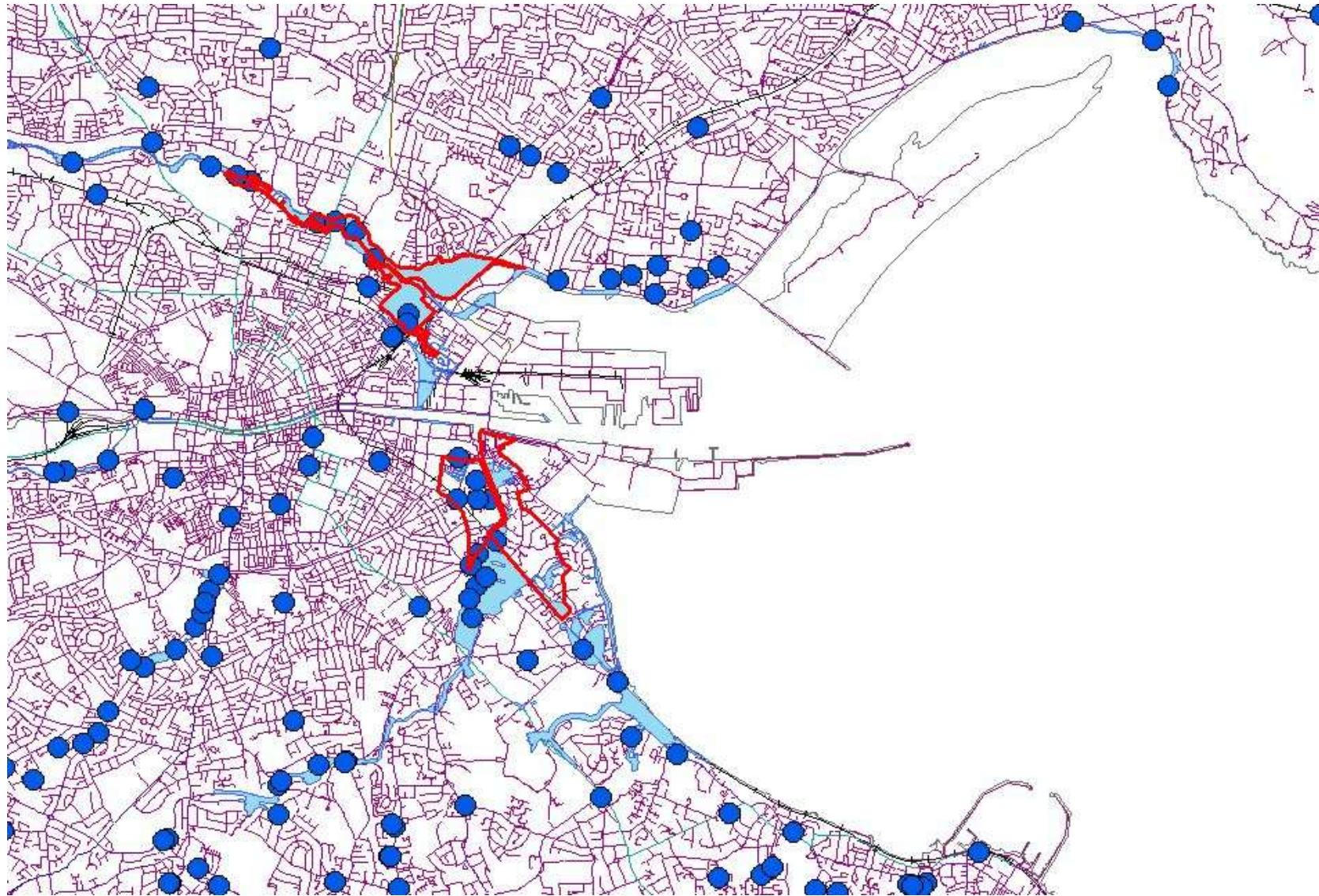
Flood data comes from the OPW: Preliminary Flood risk Maps released Nov 2011



CFRAM risk Maps released 2014



Flood events and defences (Dublin)



Our analysis follows the standard hedonic regression approach using spatial fixed effects

- Log of the listed sale of a dwelling is a function of:
 - **Dwelling Characteristics**
 - Size, Type, BER
 - **Time year-quarterly controls**
 - **Neighbourhood quality Small Area controls**
 - % unemployed, % degree
 - **Nearby amenities**
 - Socio-economic: CBD, Schools, Transport etc
 - Natural: Coastline, Sea views, River views
 - **Location fixed effects**
 - Market, Micro-market, Electoral District, Small Area
 - **Flood risk and events**

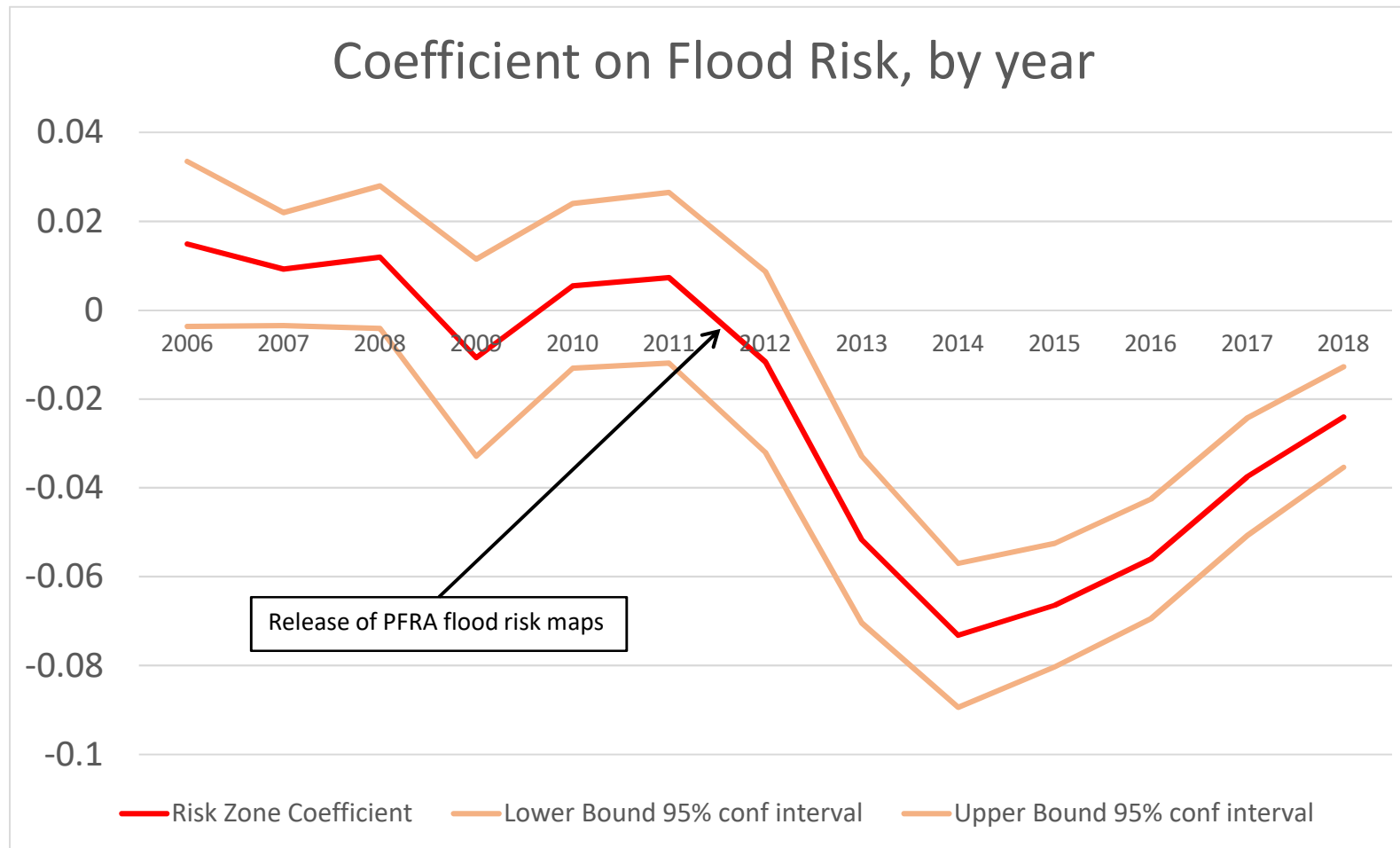
Flood Variables

- Flood Risk
 - Categorical variable with distance bands to low risk zone and within:
500-200m, 200-100m, <100m, within low risk, within medium-high risk (base >500m from low risk zone)
- Flood Defences
 - Flood risk variable above expanded by interaction with a defence dummy:
0 if pre construction of defence (and all observations outside of defence polygon), 1 if post construction
- Flood Events
 - Categorical variable based on time since most recent flood event:
>30 years since event, 30 – 10 years, 10- 5 years, 5- 2 years, <2 years (Base no recorded flood event in proximity to dwelling)

Baseline sample

- Sample Restrictions:
 - Building Level Accuracy
 - Price between 30k – 2 million
 - Within Areas of Further Assessment (AFA)
 - All listings from January 1st 2011
- Sample size: ~190,000

Flood Risk and Housing Market Cycle



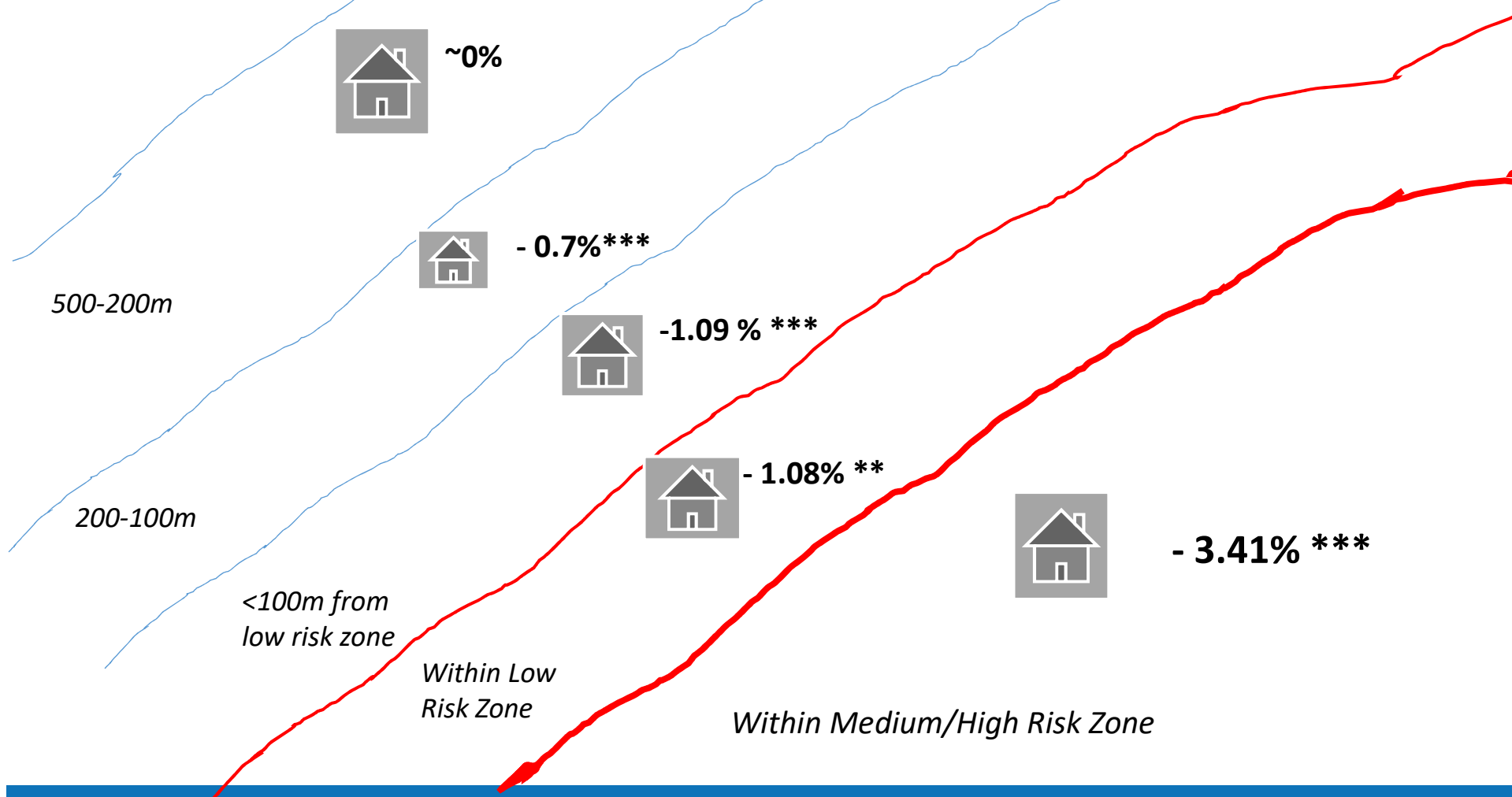
Flood Risk Headline Results

VARIABLES	Pre 2011	Post 2010
	Log (List Price)	Log (List Price)
Pre Defence		
1.Flood Risk (500-200m)	-0.00585** (-2.43)	-0.00104 (-.521)
2.Flood Risk (200-100m)	0.000442 (.142)	-0.00703*** (-2.71)
3.Flood Risk (<100m from low risk)	-0.0144*** (-4.22)	-0.0109*** (-3.99)
4.Flood Risk (inside low risk)	-0.00804 (-1.06)	-0.0108** (-2.09)
5.Flood Risk (inside med or high)	0.00299 (.305)	-0.0341*** (-5.35)
Post Defence		
10.Flood Risk (inside med or high)	0.0733*** (3.39)	0.108*** (5.52)
Flood Events	YES	YES
Dwelling Controls	YES	YES
Time Controls	YES	YES
Neighbourhood Quality Small Area Controls	YES	YES
ED fixed effects	YES	YES
Nearby Amenities Controls	YES	YES
Constant	12.17*** (121)	11.68*** (172)
Observations	94,133	190,274
R-squared	0.788	0.842
rmse	0.222	0.262
Absorbed Spatial Fixed Effects	962	1028

Graphic illustration of house price discounts based on coefficients for flood risk, by distance categories



Base: All observations >500m from low risk zone & within AFA



Flood Risk Robustness Checks

VARIABLES	Markets	Micro Markets	ED	Small Area	Transactions Sample	Listings Clustered
	Inprice	Inprice	Inprice	Inprice	Intprice	Inprice
Pre Defence						
1.Flood Risk (500-200m)	-0.0204*** (-11.3)	-0.00135 (-.735)	-0.00104 (-.521)	-0.00103 (-.303)	0.00285 (.862)	-0.00104 (-.165)
2.Flood Risk (200-100m)	-0.0372*** (-15.6)	-0.0124*** (-5.12)	-0.00703*** (-2.71)	-0.00432 (-.967)	-0.00233 (-.536)	-0.00703 (-.802)
3.Flood Risk (<100m from low risk)	-0.0460*** (-19.1)	-0.0134*** (-5.35)	-0.0109*** (-3.99)	-0.00283 (-.566)	-0.0120** (-2.45)	-0.0109 (-1.09)
4.Flood Risk (inside low risk)	-0.0671*** (-13.3)	-0.0120** (-2.41)	-0.0108** (-2.09)	-0.0121 (-1.6)	-0.0279*** (-2.87)	-0.0108 (-.842)
5.Flood Risk (inside med or high)	-0.0814*** (-12.8)	-0.0167*** (-2.66)	-0.0341*** (-5.35)	-0.0187** (-2.12)	-0.0623*** (-4.26)	-0.0341** (-2.09)
Post Defence						
10.Flood Risk (inside med or high)	-0.0297 (-1.61)	0.0716*** (3.74)	0.108*** (5.52)	0.117*** (4.19)	0.0206 (.734)	0.108*** (3.29)
BER Controls	NO	NO	NO	NO	YES	NO
Dwelling Controls	YES	YES	YES	YES	YES	YES
Time Controls	YES	YES	YES	YES	YES	YES
ED fixed effects	YES	YES	YES	YES	YES	YES
Small Area Neighbourhood Quality Controls	YES	YES	YES	NO	YES	YES
Nearby Amenities Controls	YES	YES	YES	YES	YES	YES
Constant	12.59*** (602)	11.90*** (330)	11.68*** (172)	12.00*** (57.9)	10.88*** (71.8)	11.68*** (47.2)
Observations	190,691	190,691	190,274	190,691	35,922	190,274
R-squared	0.808	0.834	0.842	0.874	0.897	0.842
rmse	0.289	0.268	0.262	0.241	0.172	0.262
k_absorb	54	375	1028	10809	322	1028

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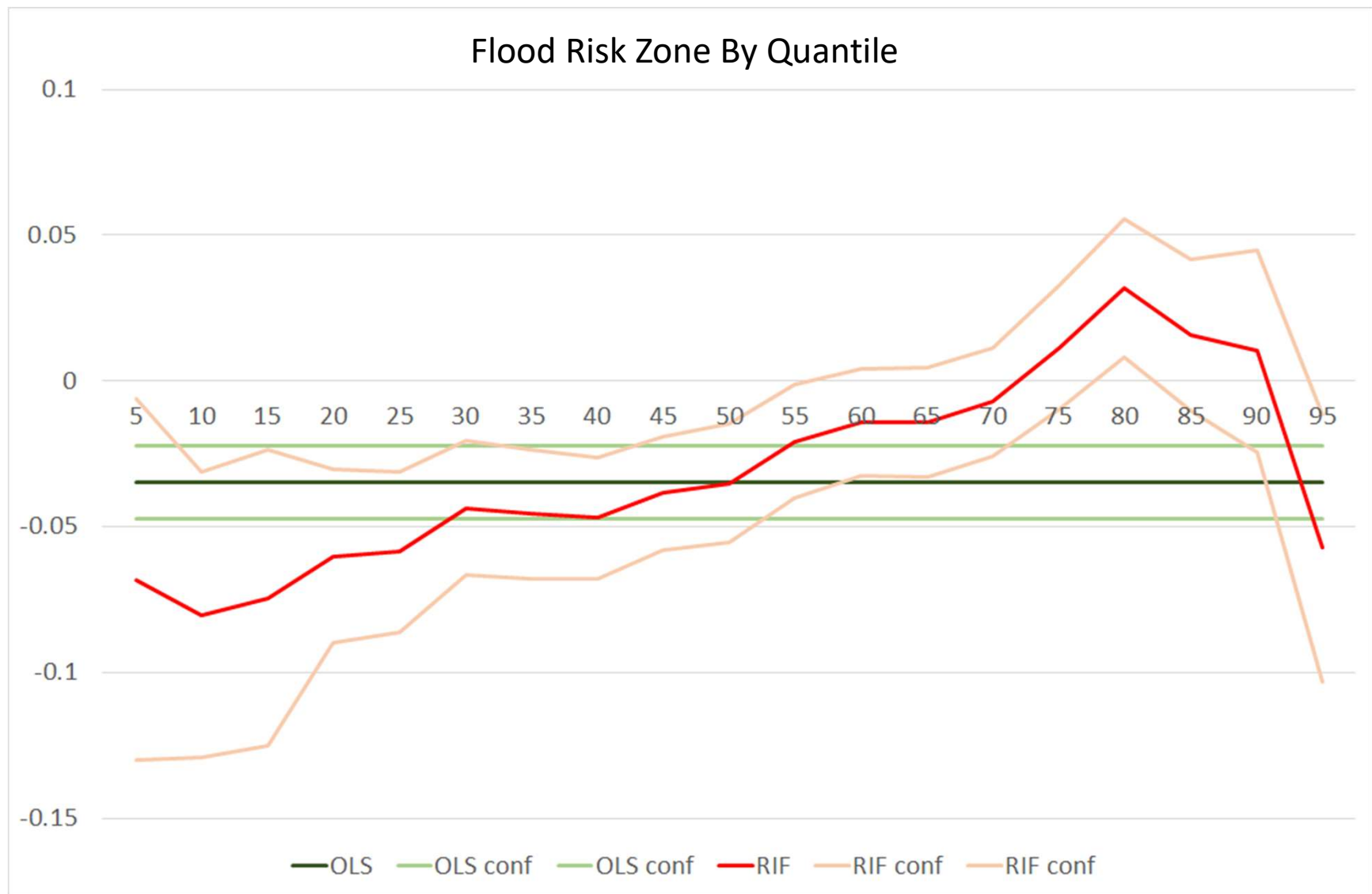
Flood Events Headline Results

VARIABLES	Market	Micro-Market	ED	Small Area
	Inprice	Inprice	Inprice	Inprice
250 m radius from listing (base = no floods < 250m)				
1.Flood Events (>30years)	-0.0797** (-1.99)	-0.0619 (-1.64)	-0.0400 (-1.05)	-0.0483 (-1.19)
2.Flood Events (10-50 years)	0.0498*** (6.46)	0.0134* (1.8)	-0.0164** (-2.22)	-0.00443 (-.47)
3.Flood Events (5-10 years)	-0.00764 (-1.16)	-0.0173*** (-2.82)	-0.0103* (-1.66)	0.00451 (.582)
4.Flood Events (2-5 years)	0.0194*** (2.58)	0.00782 (1.1)	0.0155** (2.15)	0.0290*** (3.44)
5.Flood Events (<2 years)	-0.0289*** (-2.62)	-0.0337*** (-3.21)	-0.0305*** (-2.91)	-0.0212* (-1.91)
100m radius from listing (including polygon data)				
6.Flood Events (>30years)	-0.0252** (-2.29)	-0.0292*** (-2.79)	-0.0367*** (-3.32)	0.0149 (1.15)
7.Flood Events (10-50 years)	0.0477*** (6.14)	0.0213*** (2.81)	0.0119 (1.57)	-0.000326 (-.0334)
8.Flood Events (5-10 years)	-0.00222 (-.165)	-0.0113 (-.873)	-0.00945 (-.749)	-0.00425 (-.3)
9.Flood Events (2-5 years)	-0.0261* (-1.81)	-0.0284** (-2.07)	-0.0130 (-.95)	0.00695 (.448)
10.Flood Events (<2 years)	-0.0592** (-2.49)	-0.0628*** (-2.84)	-0.0457** (-2.1)	-0.0544** (-2.43)
Flood Risk	YES	YES	YES	YES
Dwelling Controls	YES	YES	YES	YES
Time Controls	YES	YES	YES	YES
Small Area Neighbourhood Quality Controls	YES	YES	YES	NO
ED fixed effects	YES	YES	YES	YES
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Quantile Regressions



Results Summary

1. **Information matters** – prices responded dramatically to the release of flood risk maps in 2011, with the emergence of an 3.41% discount for a 1 in a 100 risk zone or higher
2. **Flood defences work:** the discount for flood risk is reversed into a 10% premium (or disappears in transactions sample) after the construction of defences
3. **The market's memory of flood events is short** – a 4.5% price discount for being within a flood event disappears after two years
4. **Flood risk is borne unequally:** properties in lowest decile of value suffer a ~8% discount, compared to no statistically significant one in the top decile

Empirical Issues

- Use of **4 levels of spatial fixed effects** shows that key variables show low levels of sensitivity
- Transactions sub-sample includes detailed levels of property characteristics. **BER data**
- **List price vs transaction price** in sub sample shows negligible differences in coefficients, suggesting that list prices are a very good proxy for transacted prices
- Key variables are largely robust to **clustering** of error term within spatial fixed effects
- Confident that some **spatially unobserved process**, correlated with flood risk, within Electoral Districts, is unlikely to be driving our results. Evident in the fact that there is no pattern pre 2011.

Rising Waters, Falling Prices

Contribution

- One of the first papers (together with Bosker et al, Gharbia et al) to assess price elasticity of flood risk, not past flood events
- The first paper [we know of] that:
 - Shows updating in response to new flood risk information
 - Shows a causal effect of flood defences by type on housing prices
- Confirms finding of ‘fading memory’ of flood events

Aggregate Irish Figures

- Average House price within AFA in 2018: €304,654
- Total number of Eircodes within medium/high flood risk zones (not Defended): 28,082
- Flood risk discount identified by model: -3.41%
- $€304,654 * 28,082 * 0.0341 =$
Total cost of flood risk: ~ € 291 million

Rising Waters, Falling Prices

Policy Implications

- Flood Risk Discount
 - Important to identify people's willingness to pay to avoid flood risk
- Information Matters
 - Investing in information provision
- Defences work and Flood Risk is Bourne Unequally
 - Allocation of Defences
 - High Density low value properties vs low density high value properties
 - Issues with flood insurance

Future Work

- Survey analysis
 - Daft.ie survey, ~600 respondents
- More detailed look into flood defences, by type, cost, and their allocation
 - €1billion in projected spending in Ireland over next 10 years
- Climate change scenarios
 - OPW has produced different versions of maps based on climate change scenarios

Thanks for Listening!

Spatial Fixed Effects

Transaction Price (Dublin) Sample (~39,600 observations)

Fixed Effect	Number of spatial units in sample	Mean Number of Observations Within Spatial Unit	Median Number of Observations Within Spatial Unit
Local-Market	26	2,241	1,990
Micro-Market	118	576	435
Electoral District	322	242	145
Small Area	4,557	11	11

Nationwide listings sample 2011-2018 within AFA (~190,000 observations)

Fixed Effect	Number of spatial units in sample	Mean Number of Observations Within Spatial Unit	Median Number of Observations Within Spatial Unit
Local-Market	54	5,142	4,393
Micro-Market	375	2,027	1,490
Electoral District	1,028	767	485
Small Area	10,815	38	32