Dynamics of the Long Term Housing Yield: Evidence from Natural Experiments

Verónica Bäcker-Peral
Princeton

Jonathon Hazell
LSE

Atif Mian
Princeton

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Expected Long Term Housing Yield

y^* is housing yield or rent-price ratio of housing expected in long run

$$y^* = \lim_{h \to \infty} E_t \frac{R_{t+h}}{P_{t+h}} = r^* + \zeta^* - g^*$$

- r^* is long run risk free rate, ζ^* is long run housing risk premium, g^* is long run capital gain

$\rightarrow$ y^* contains information about market's expected long run equilibrium

How much did long term yields fall by in recent decades? Will the current rise in yields prove transitory?

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How much did long term yields fall by in recent decades? Will the current rise in yields prove transitory?

But y^* is hard to measure

- Discount rates affected by shorter term shocks (e.g monetary policy)
- Dividend of capital often hard to observe (e.g service flow of owner occupied housing)

Measuring Dynamics of y^* With Natural Experiments + Microdata

This paper: natural experiments + microdata to measure y^*

A natural experiment in the UK property market

- Long duration (> 70 year) leased properties quasi-randomly extend lease by 90+ years
- Put together new adminstrative data on $130,000+$ lease extension experiments, 2000 onward
- Extension price change for same property: "differences out" shorter term shocks + service flow

$\rightarrow$ Identifies y^* for UK property at very long horizon with few structural assumptions

Data and code made public, updated in real time (monthly)

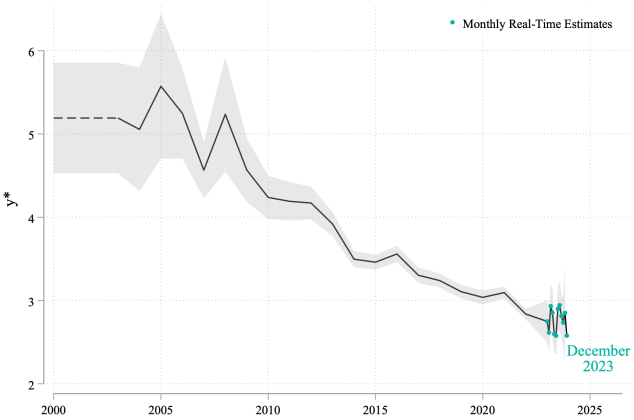
Main Results: Big Fall Before 2022, Stable After

1. y^* for UK property market fell from 5.3% during 2000-2006 to 2.8% by 2022

2. y^* stable during and after Pandemic Recession

3. Decline in y^* is broad based beyond housing

Implication: $y > y^*$ as an indicator



95% confidence intervals shaded

The Long Term Housing Yield: Definition and Challenges

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- Price P_t of capital with dividend R_t:

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where r is safe return, ζ is risk premium, g is dividend growth, y is yield

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- The long term housing yield is long-run expected yield

$$y^* = r^* + \zeta^* - g^* \equiv \lim_{u \to \infty} r(u) + \zeta(u) - g(u) = \frac{R_{t+\infty}}{P_{t+\infty}}$$

  → **Equivalent:** y^* is long run dividend-price ratio; **or** user cost of capital normalized by price

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$$y^* = r^* + \zeta^* - g^* \equiv \lim_{u \to \infty} r(u) + \zeta(u) - g(u) = \frac{R_{t+\infty}}{P_{t+\infty}} \neq \frac{R_t}{P_t}, \quad \text{"naive estimate"}$$

  → **Equivalent:** y^* is long run dividend-price ratio; **or** user cost of capital normalized by price

- **Two challenges** in estimating y^*:
  1. Dividend of capital R_t often hard to observe (e.g. service flow of owner occupied housing)
  2. Shocks to shorter end of yield curve also affects P_t (e.g monetary policy)

Data and Lease Extensions

Data

"Leasehold" = long duration lease issued by owner of property ("freeholder"), typically > 70 years

- Originally designed to give liquidity to cash poor aristocrats
- 97.5% of apartments, 7.3% of houses are leaseholds, lease can be bought and sold

Lease extensions:

- Leaseholder entitled to extend lease by 90 years by paying freeholder a one-off negotiated payment
- If no agreement: payment is present value of lease extension assessed by tribunal with market prices

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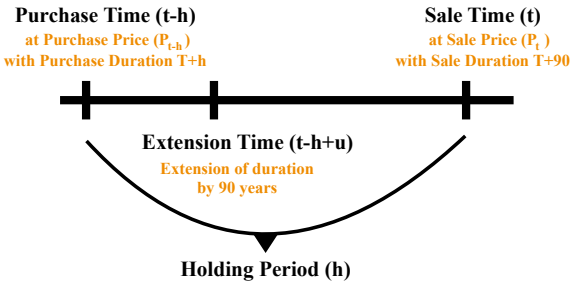
Main datasets:

1. **Land Registry Sales**: all residential sales in England and Wales, 1995-present, public data
2. **Land Registry Leases**: all lease terms for leaseholds, public data
3. **Land Registry Extensions:** new data on date and size of extensions, private data
   - NB: lease extension payments not measured
   - We have made extension data set publicly available on our website, for replication + real time analysis
4. **Rightmove / Zoopla**: hedonics (e.g. # bedrooms, # bathrooms, # living rooms, floor area)

Other Data | Heatmap | Ground Rents

Lease Extensions: Example and Sample Construction



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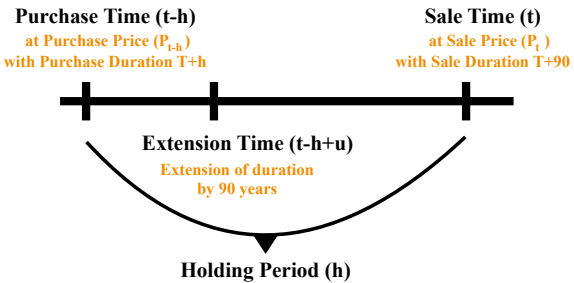
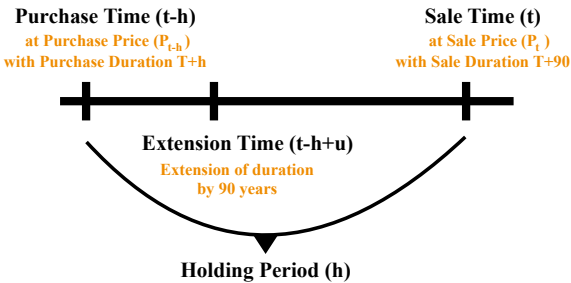


Main Sample:

- Lease extensions with transaction both before and after extension
- Exclude "flippers" who buy + extend + sell within a year
- Focus on 90 year lease extensions (typical length) Extension Amount Histogram

Lease Extensions: Example and Sample Construction



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Summary statistics:

- 40,633 lease extensions for 90 years (122,224 lease extensions total)
- Median duration before extension is **large** $\approx$ 70 years
- Median holding period 10 years, time to extension 7 years

Using Lease Extensions to Estimate y^*

Empirical Methodology I

Price of **leasehold** P_t^T with T years until expiry

$$P_t^T = R_t \int_0^T e^{-\int_0^S y(s)ds} dS$$

In paper: estimate option value of lease extension with discontinuity based estimator, results unchanged

Empirical Methodology II

Price change after lease extension difference-in-difference:

$$\Delta_{it} \equiv \overbrace{\left[\log P_{it}^{T+90} - \log P_{i,t-h}^{T+h}\right]}^{\text{price growth after extension}} - \overbrace{\left[\log P_{jt}^{T} - \log P_{j,t-h}^{T+h}\right]}^{\text{non-extending control}}$$

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$$= \log\left(\int_0^{T+90} e^{-\int_0^S y(s)ds} ds\right) - \log\left(\int_0^{T} e^{-\int_0^S y(s)ds} ds\right) + \underbrace{\Delta_{t,t-h}\left(\log R_{it} - \log R_{jt}\right)}_{\text{service flow growth extender vs. control}}$$

Identification: service flow growth of extender same as **suitably chosen control group** ("parallel trends")

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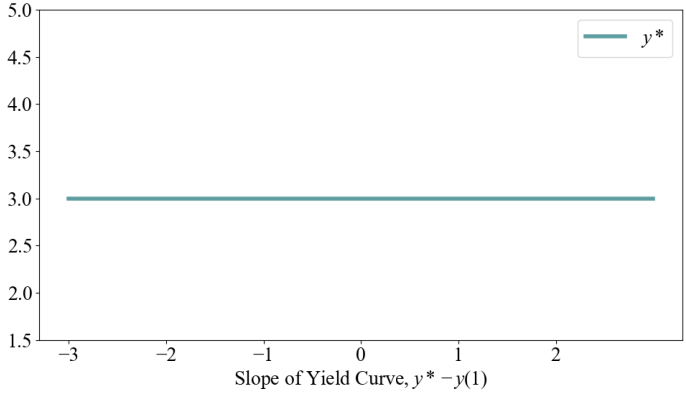
Identification: service flow growth of extender same as **suitably chosen control group** ("parallel trends")

Advantages of estimator—w/ minimal structural assumptions

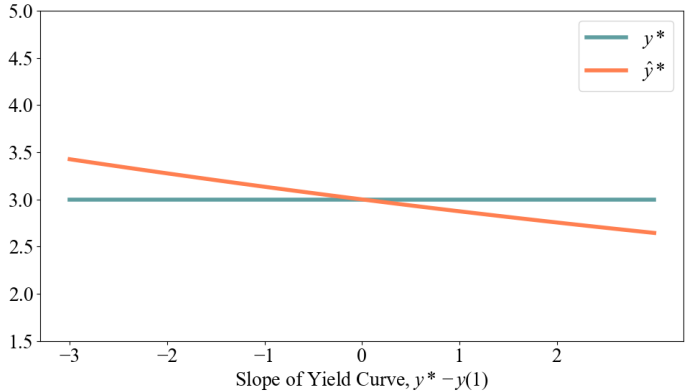
- ✓ Differences out (unobservable) service flow of housing incl. taxes + depreciation
- ✓ Differences out shorter term rates: **when T is large**, y^* is identified from long duration cashflows (despite parametrization of constant y^*)

Estimator "Differences Out" Shorter Term Yields (Numerical Result)



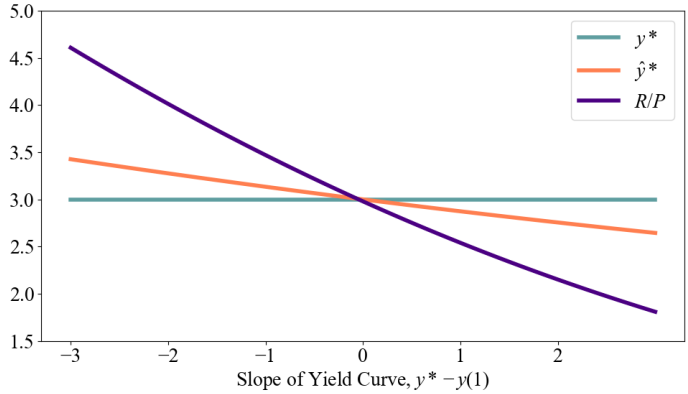
- Simulate panel of leases: **flat** yield curve at **long end** ($T > 50$), **sloped** yield at **short end** ($T < 50$)
  - Apply estimator $\hat{y}^*$ as slope of yield curve $y^* - y(1)$ varies, hold fixed y^*

Estimator "Differences Out" Shorter Term Yields (Numerical Result)



- Simulate panel of leases: **flat** yield curve at **long end** ($T > 50$), **sloped** yield at **short end** ($T < 50$)
- Estimator has **small** bias for **large** variation in slope
  - *Intuition:* **duration at extension is large** $\rightarrow$ y^* is identified from long duration cashflows

Estimator "Differences Out" Shorter Term Yields (Numerical Result)



- Simulate panel of leases: **flat** yield curve at **long end** ($T > 50$), **sloped** yield at **short end** ($T < 50$)
- Estimator has **small** bias for **large** variation in slope
- "Naive estimator" R_t/P_t has large bias when yield curve sloped

Empirical Methodology III

Price change after lease extension difference-in-difference:

$$\Delta_{it} = \log\left(1 - e^{-y_t^*(T_{it}+90)}\right) - \log\left(1 - e^{-y_t^* T_{it}}\right)$$

Control: repeat sales index of non-extenders within d km and 5 years of extender duration T_{it}

- d is smallest possible distance, typically under 5km
- Robustness: residualize prices by hedonic characteristics

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Validating control group + parallel trends:

- ✓ Balance test: hedonics vs. treatment Balance Test
- ✓ Placebo: growth in (market) rents + hedonics vs. treatment Hedonics Rent Growth Long-Run Rent Growth
- ✓ Lack of pre-trends: growth in prices before extension vs. treatment
- ✓ Stable coefficients w/ controls

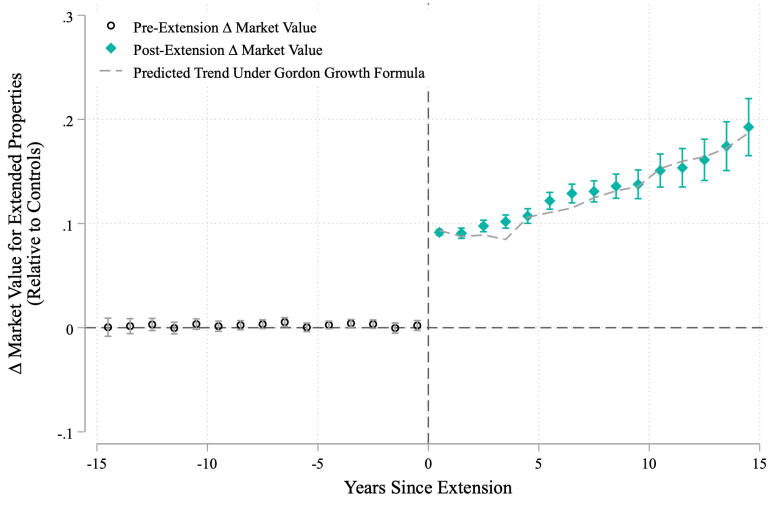
Nonlinear least squares: estimate y_t^* given (Δ_{it}, T_{it}) from lease extensions

- Time varying estimator of y_t^* is feasible

Estimates of Level of y^*

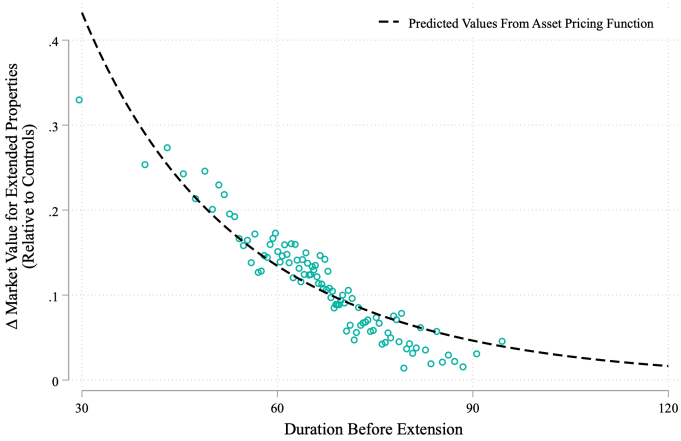
Event Study of Lease Extension

Event Study Plot Over Time & Duration | Lease Term Distribution



Price change from lease extension helps to identify y^*

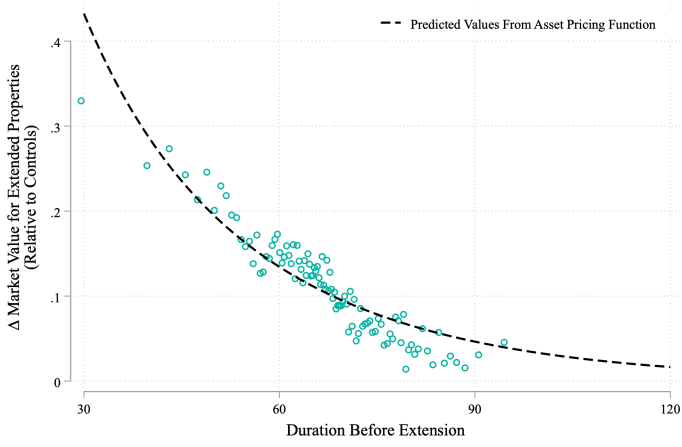
Duration Before Extension Predicts Price Change After Extension



Binscatter with 100 bins, 90 year extensions

Model prediction: price gain from extension decreasing in duration before extension (helps to identify y^*)

Duration Before Extension Predicts Price Change After Extension



Binscatter with 100 bins, 90 year extensions

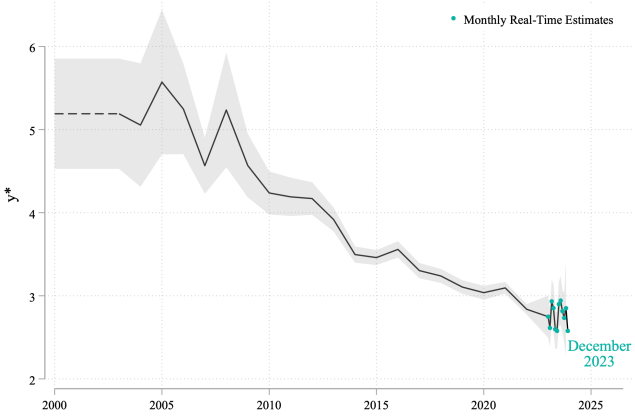
Estimates of y^*

Average estimate: $y^* = 3.5\%$ y^* Estimates

Main Results: Dynamics of y^*

Result #1: Trend Dynamics Of y^*

Yield Curve Dynamics | Timeseries by Extension Amount



95% confidence intervals shaded

Fall of y^* from 5.3% to 2.8%, near doubling of long-term price-rent ratio

Result #1: Trend Dynamics Of y^*

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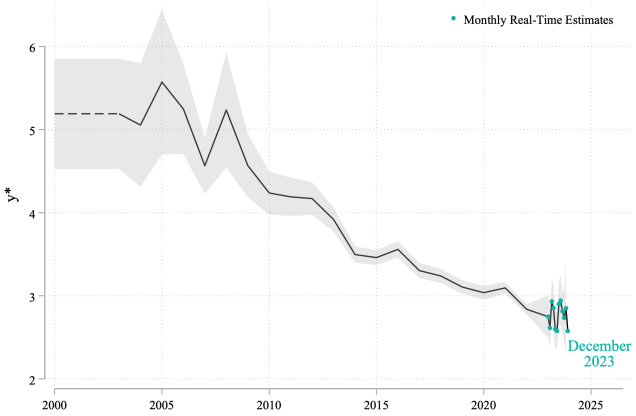

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SEs $\approx$ order of magnitude lower than r^* estimate of Holston, Laubach & Williams HLW Estimates

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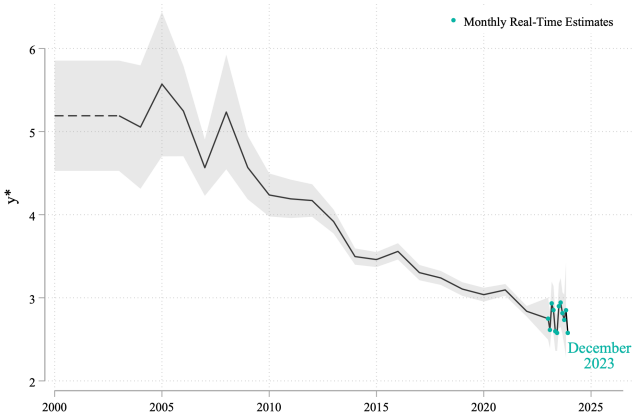
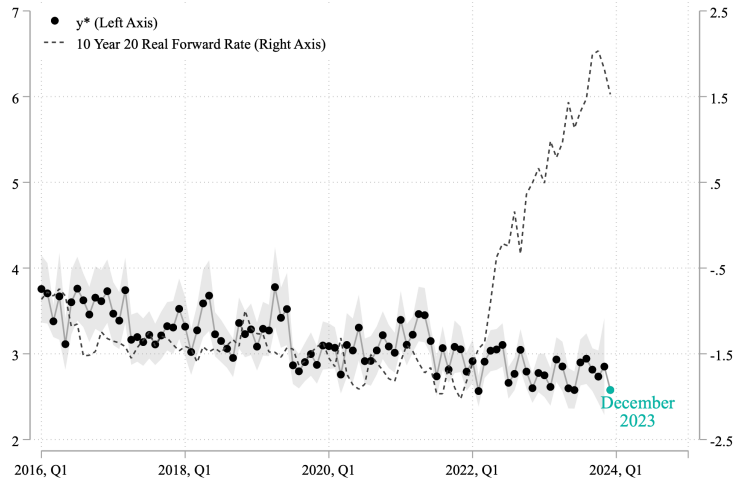


95% confidence intervals shaded

Here: decline in y^* for housing

- Previous work shows decline in **government bond yields**

Result #2: Real Time Dynamics of y^*



3-6 month lag in real-time estimate of y^* due to closing period Histogram

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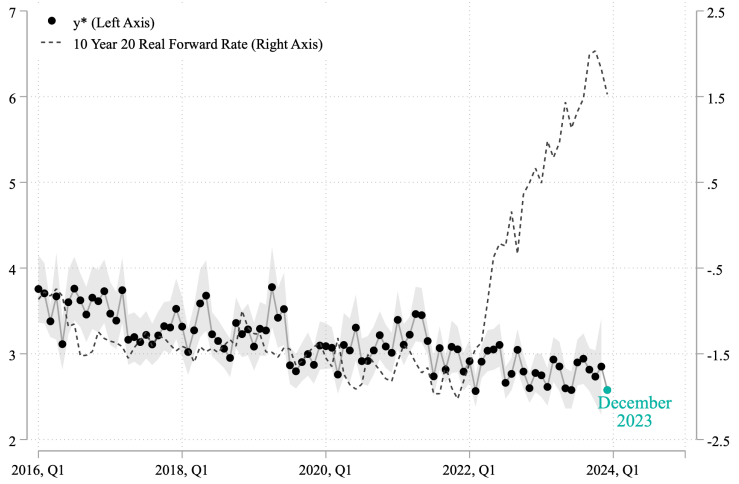
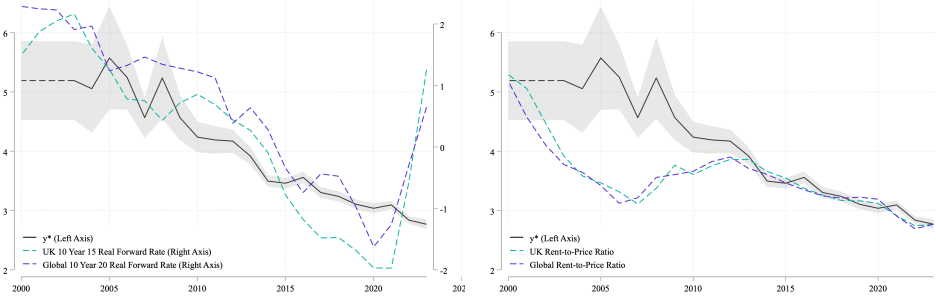


real-time data made public $\approx$ 900 lease extensions per month

Result #3: Macroeconomic implications of y^*



(a) Real Risk-Free Forward Rate

(b) Rent-to-Price Ratio

- Decline in y^* reflects that of other asset yields at low frequencies
- Deviations of y from y^* suggest transitory movements in yields

Conclusion

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Natural experiment to estimate long term housing yield

1. y^* for UK property market fell from 5.3% during 2000-2006 to 2.8% by 2022
2. y^* stable during and after Pandemic Recession
3. Decline in y^* broad based beyond UK housing

Key advantages:

1. Precision, even at monthly frequency
2. Addresses model misspecification concerns
3. Real time estimates, data made publicly accessible

Other Data

1. **Rightmove Data**: Hedonics including # bedrooms, # bathrooms, # living rooms, floor area, property age, parking, heating type, condition, rental rates
2. **Zoopla Data**: Hedonics including # bedrooms, # bathrooms, # receptions, # floors, rental rates
3. **HMCTS Tribunals Data**: All Residential Property tribunal decisions on extension cases.

◂ Data & Lease Extensions

Ground Rents

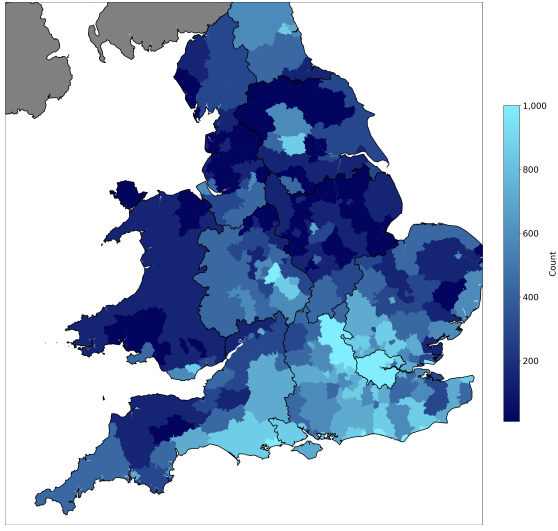
1. Ground rents are typically a negligible amount of the property value, with a median price of £10 per annum, according to English Housing Survey

2. Ground rents are present for leases of all lengths, including very long 700+ year leases

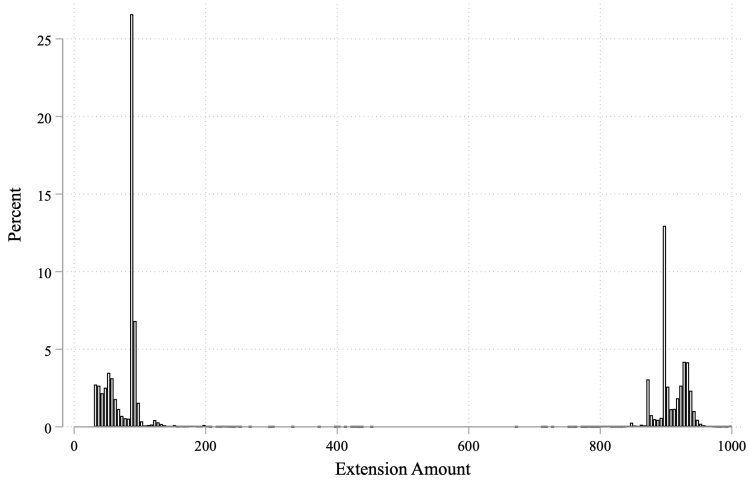
3. To collect ground rents, freeholders must make a specific written request to the leaseholder, so many freeholders find it cheaper not to collect ground rents

◂ Data & Lease Extensions

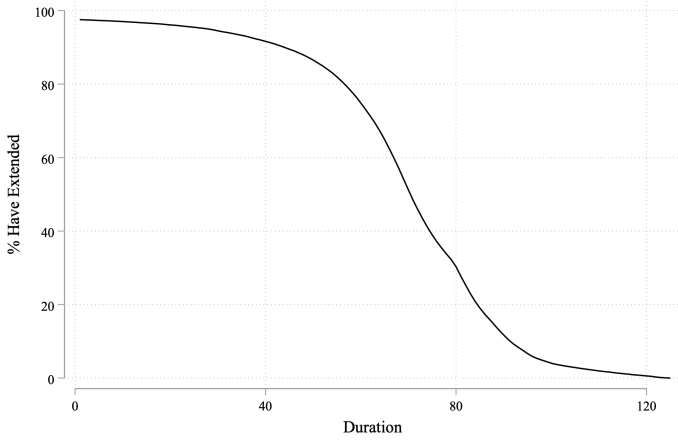
Lease Extension Heat Map



Extension Amount Distribution

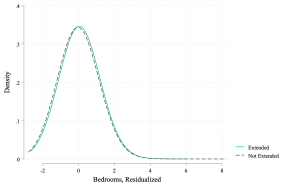


Cumulative Hazard Rate

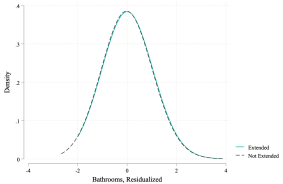


Estimator

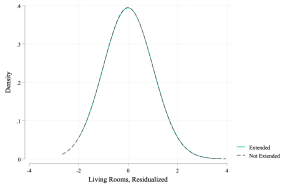
Hedonics Balance Test



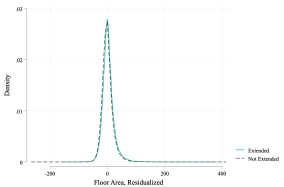
(a) Bedrooms



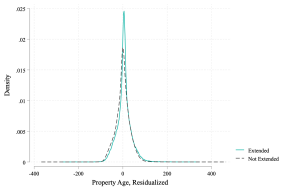
(b) Bathrooms



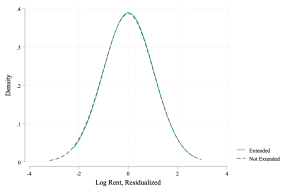
(c) Living Rooms



(d) Floor Area



(e) Age



(f) Log(Rent)

◂ Main Estimator

Hedonics Placebo Test

	(1) Renovation Rate	(2) Δ Bedrooms	(3) Δ Bathrooms	(4) Δ Living Rooms	(5) Δ Floor Area
Extension	-0.001	-0.003	0.000	-0.001	-0.057
	(0.001)	(0.002)	(0.000)	(0.000)	(0.035)
Experiment FE	✓	✓	✓	✓	✓
Control Mean	.091	.043	.002	.001	.28
N	148,786	41,760	31,734	30,630	33,122
N. Experiment	74,393	20,880	15,867	15,315	16,561

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

◂ Main Estimator

Rent Growth Placebo Test

	Δ log(Rent)		
	(1)	(2)	(3)
Extension	0.0010	-0.0010	0.0002
	(0.0007)	(0.0006)	(0.0007)
Experiment × Rent Years FE	✓		✓
Experiment FE		✓	
Annualized		✓	
RSI			✓
N	3,874,527	35,474	72,558
N. Experiment	16,131	17,737	18,447

Standard errors in parentheses

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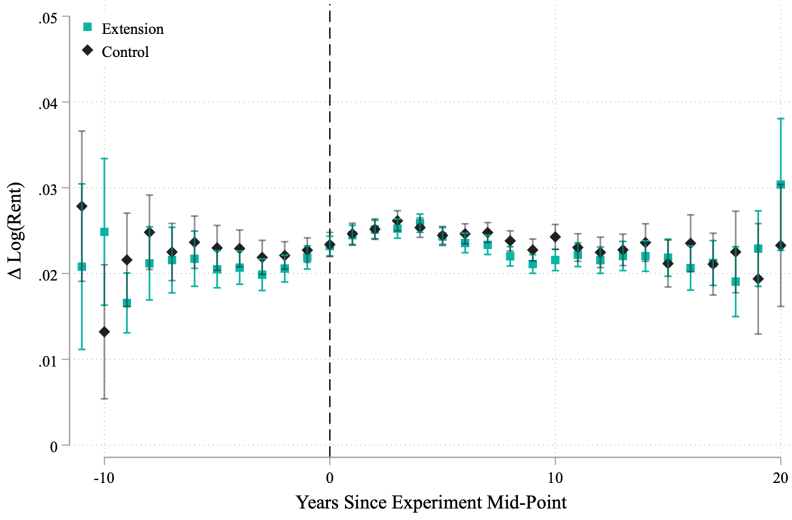
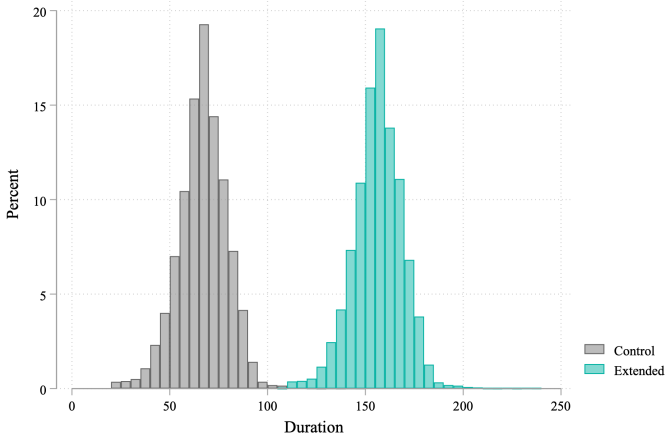
◂ Main Estimator

Long-Run Rent Growth



Main Estimator

Lease Term Distribution



Main Estimator Event Study

Estimating The Long Term Housing Yield on UK Property

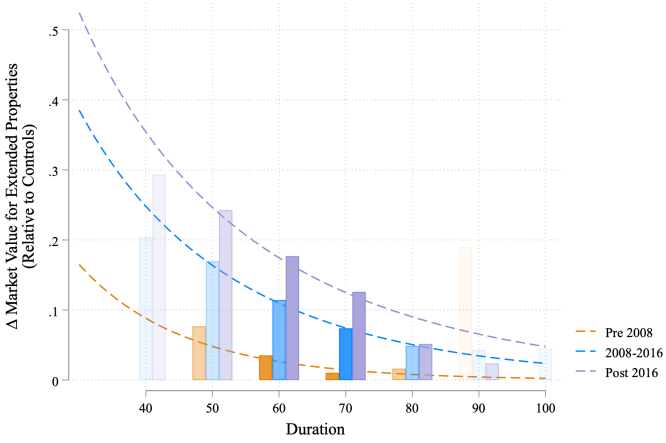
	Constant y^*	Flexible y^*				Constant y^*
	(1)	(2)	(3)	(4)	(5)	(6)
	$k = 90$	$T = 50$	$T = 60$	$T = 70$	$T = 80$	$k \geq 700$
y^*	3.47***	3.43	3.46	3.49	3.52	3.50***
	(0.023)					(0.020)
N	41,885					52,615
t-stat (700+ vs. 90)						1.11

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

◂ Binscatter

Dynamics Of The Long-Term Housing Yield



Transparency shaded by number of observations

◂ y^* Timeseries

Measuring the Option Value of Lease Extension

Cost of extending a lease with T years until expiry:

$$\kappa_{it}^{T} = \begin{cases} \min\left\{ RV_{it}^{T} + \gamma R_{it}, MV_{it}^{T} \right\} & T \geq 80 \\ \min\left\{ \frac{RV_{it}^{T} + MV_{it}^{T}}{2} + \gamma R_{it}, MV_{it}^{T} \right\} & T < 80 \end{cases}$$

- **Reversion Value**: $RV_{t}^{T} = \frac{R_{it}}{r_{RV}} \left(e^{-r_{RV} T} - e^{-r_{RV}(T+90)} \right)$ uses court discount rate $r_{RV} = 5\%$
- **Marriage/Market Value**: $MV_{it}^{T} = P_{it}^{T+90} - P_{it}^{T}$
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Define $\alpha_{t}^{T} \equiv \kappa_{it}^{T} / MV_{it}^{T} \leq 1$: share of the extension value that is lost by the leaseholder. We say that there is positive option value if $\alpha_{t}^{T} < 1$.

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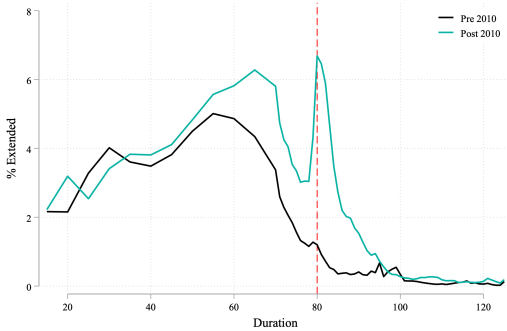
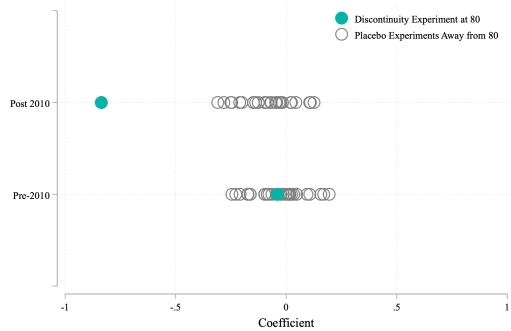
Theorem: When there is positive option value, the price of a leasehold will discontinuously fall at $T = 80$.

Discontinuity Based Test for Option Value



(a) Bunching



(b) Price Discontinuity

- Evidence of a discontinuity in the post-2010 period.

Difference-in-Differences Estimator of Option Value

	(1)	(2)
y^*	4.81***	3.25***
	(0.09)	(0.01)
α_t^H	1.00***	0.53***
	(0.01)	(0.06)
α_t^L	1.00***	1.00***
	(0.00)	(0.02)
Period	Pre 2010	Post 2010
N	18,064	106,478

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

$$\Delta_{it}^T = \log\left(1 - e^{-y_t^*(T_{it}+90)}\right) - \log\left(\left(1 - e^{-y_t^* T}\right) + \left[\Pi_{Tt}^H\left(1-\alpha_t^H\right)\right] + \left[\Pi_{Tt}^L\left(1-\alpha_t^L\right)\right] e^{-y_t^* T_{it}}\left(1 - e^{-y_t^* 90}\right)\right) \quad (1)$$

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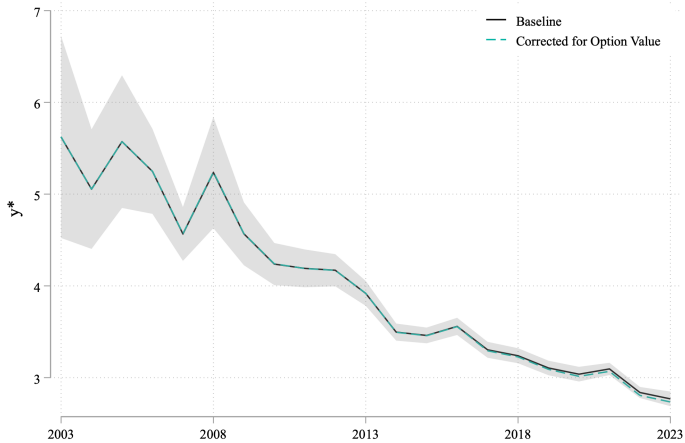
Option Value Correction



Partial Holdup Above 80 Has Negligible Effect on Estimates

◂ Bunching Estimator ◂ Robustness

Liquidity Premium

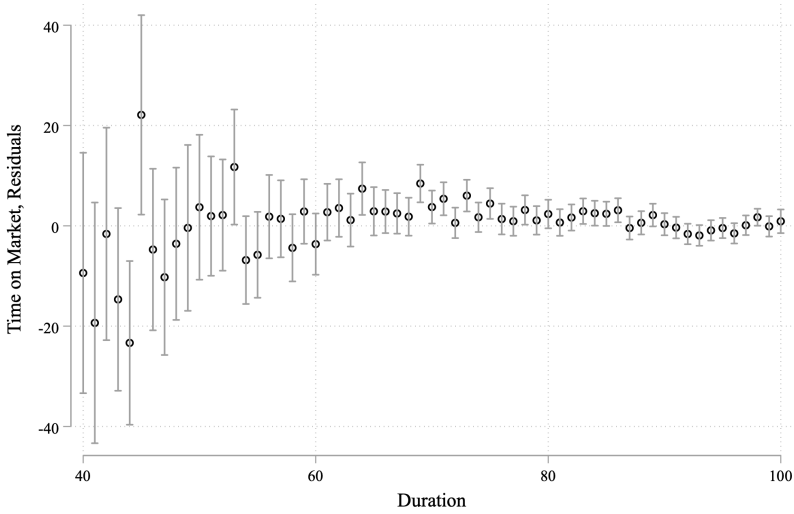
- Short and long duration leaseholds have relatively similar mortgage usage rates and conditions:

	Less Than 50 Years	50-60 Years	60-70 Years	70-80 Years	80-99 Years	100+ Years	Total
Mortgage Length	22.1	22.1	23.9	23.0	23.9	23.1	23.3
	(0.6)	(0.5)	(0.5)	(0.3)	(0.2)	(0.1)	(0.1)
LTV	76.3	80.8	81.4	77.7	73.3	76.5	76.2
	(3.3)	(2.6)	(1.8)	(1.7)	(1.0)	(0.6)	(0.5)
% Have Mortgage	59.9	60.4	62.1	58.1	63.9	55.6	58.2
	(2.4)	(2.4)	(1.6)	(1.4)	(0.8)	(0.5)	(0.4)
% Adjustable Rate	24.2	40.0	38.3	32.8	25.3	31.0	30.2
	(5.3)	(5.2)	(4.1)	(3.4)	(1.5)	(1.0)	(0.8)
N	18,292						

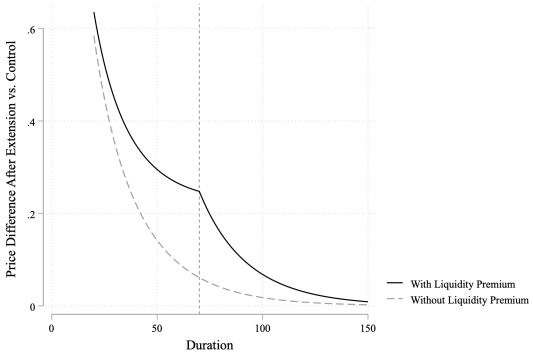
mean reported; standard error of mean in parentheses

Liquidity Premium

- Time on market is similar for leaseholds of varying durations, and is shorter for very short leaseholds



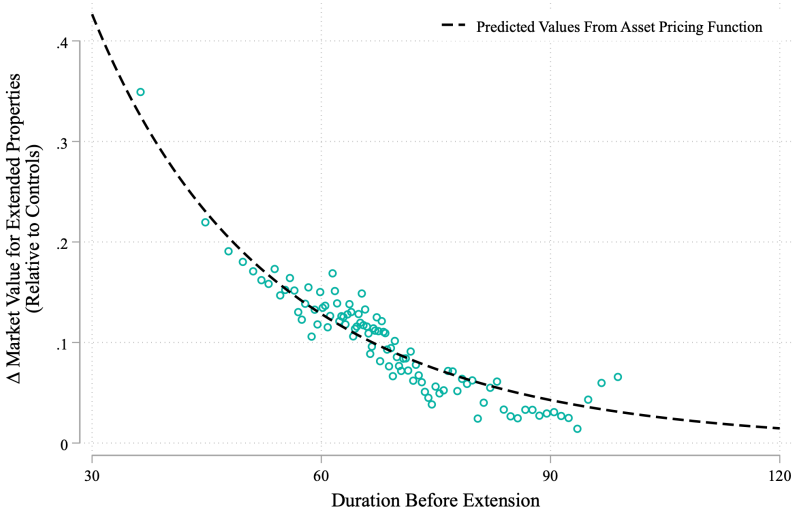
Liquidity Premium



- If there were a liquidity premium at a particular cutoff, we would see a kink in the data.
- We can test for this directly using NLLS — the data rejects a liquidity premium at 70, which is the most prominent cutoff date for several major banks such as Barclays.

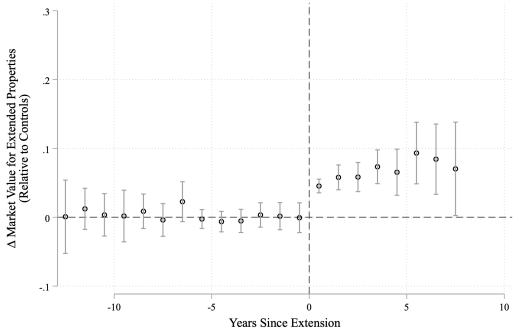
◂ Estimates of Long-Term Housing rates

Longer Extensions

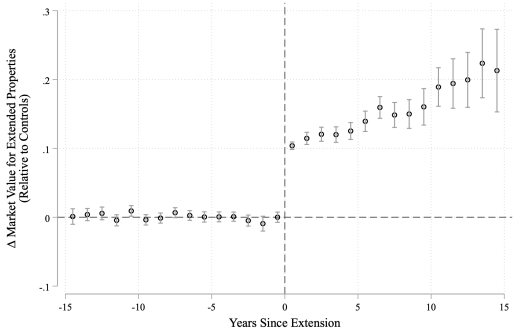


◂ Robustness

Event Study Plot Over Time

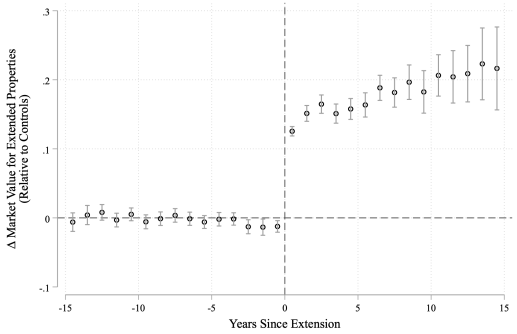


(a) Pre 2012

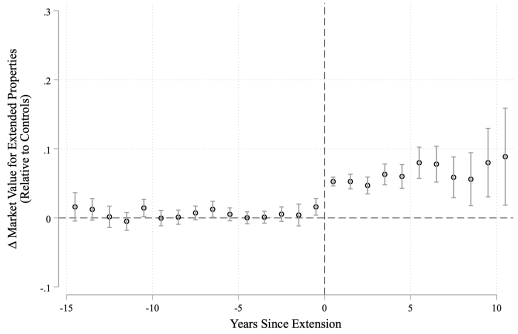


(b) Post 2012

Event Study Plot Over Duration



(a) $T < 70$



(b) $T \geq 70$

Event Study

Cross-Sectional Variation in y^*, Risk-Premium

How does the housing risk premium, ζ, vary in the cross-section?

- One measure of housing risk: the relationship between house price and consumption growth
- Proxy consumption growth with GDP growth

$$\Delta_{t,t-h} \log(\text{Price}_{ijt}) = \alpha + \beta_j \Delta_{t,t-h} \log(\text{GDP}_t) + \epsilon_{i,j,t,t-h}$$

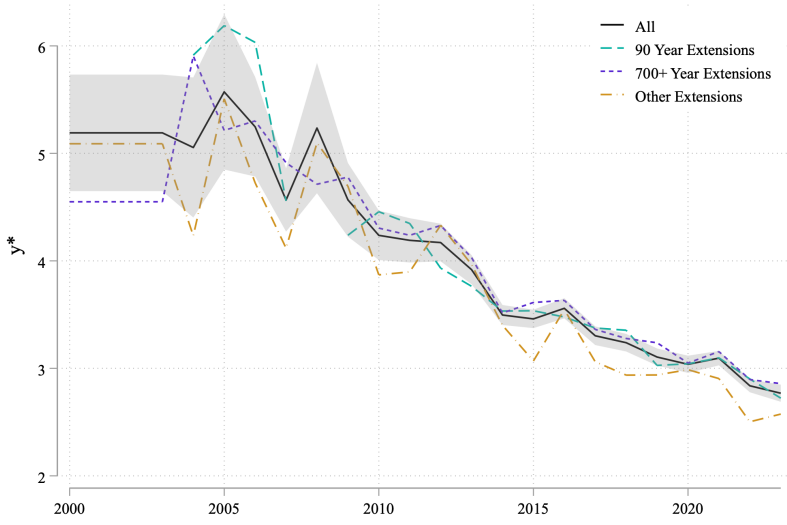
- Estimate β_j for each Local Authority j
- Estimated at the property-level (i) using change in price from $t-h$ to t

Summary statistics:

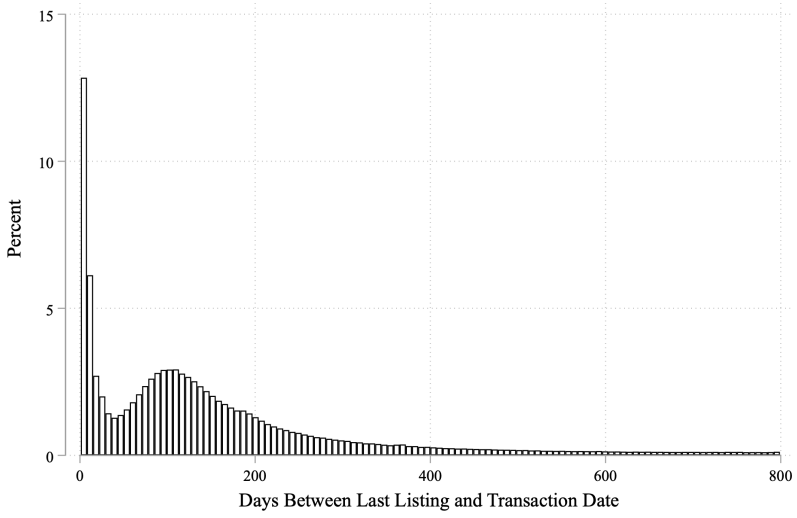
	Mean	SD
β_j	1.15	.38
Refusal Rate	.27	.09
Share developed	.38	.28

◂ Cross-Sectional Variation in y^*

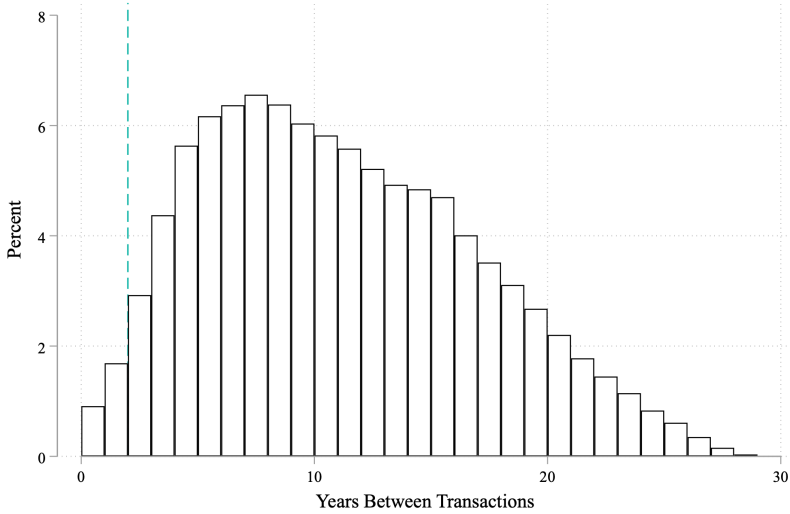
Timeseries by Extension Amount



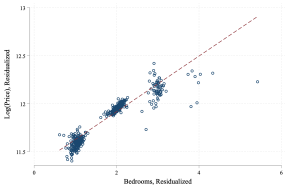
Time Elapsed Between Rightmove Listing and Transaction Date



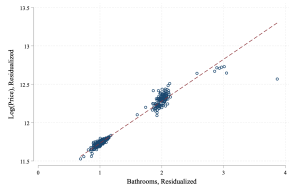
Holding Period Histogram



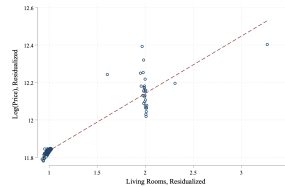
Log(Price) and Hedonic Characteristics Binscatters



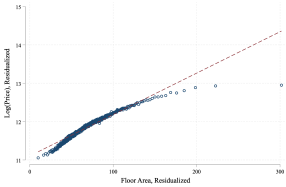
(a) Bedrooms



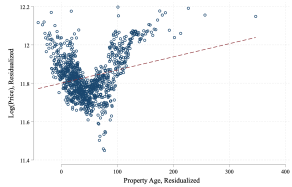
(b) Bathrooms



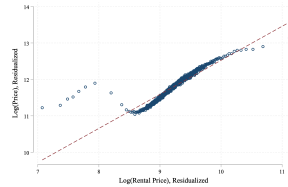
(c) Living Rooms



(d) Floor Area



(e) Age



(f) Log(Rent)

Tribunal Decision Example

Determination of the premium payable for an extended lease of 66 Brownlow Road, London N11 2BS

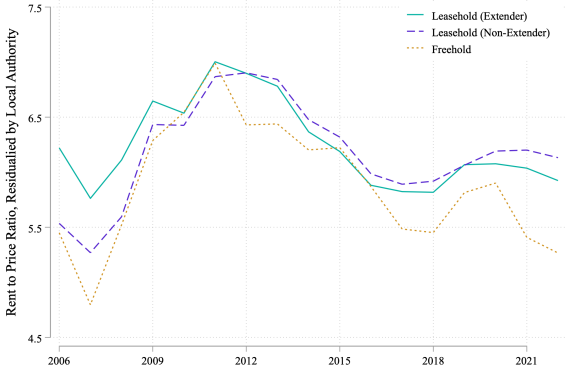
Valuation date: 21 January 2019 – Unexpired term 64.92 years

Diminution in Value of Freehold Interest

Capitalization of ground rent pa	£45		£635
YP for 64.92 years @ 7%	14.109		
Reversion to F/H value with VP	£393,900		
Deferred 64.92 years @ 5%	0.0421		£16,583
			£17,218
Less value of F/H after grant of new lease	£393,900		
Deferred 154.92 years @5%	0.000522		£205
			£17,013
Marriage Value			
After grant of new lease			
Value of extended lease	£390,000		
Plus freehold value	£205	£390,205	
Before grant of new lease			
Value of existing lease @ 83.88%	£328,500		
Plus freehold value	£17,218	£345,718	
		£44,487	
50% share to Freeholder			£22,243
			£39,256
		Premium Payable Say	**£39,250**

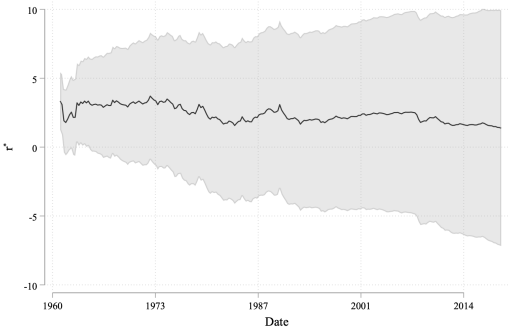
Leaseholder Representativeness

	Freehold	Leasehold
Income	29,628.73	25,653.20
	(52.95)	(138.48)
Age	53.95	51.49
	(0.03)	(0.10)
% Have Mortgage	54.82	59.07
	(0.10)	(0.28)
LTV	72.17	76.16
	(0.14)	(0.39)
N	305,135	

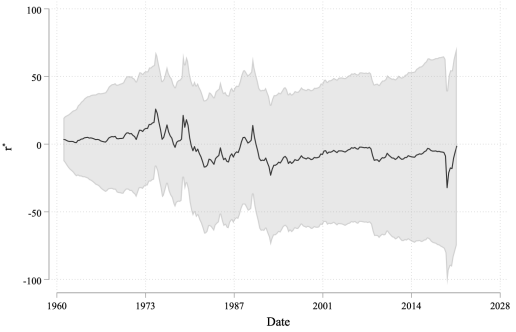


◂ Estimates of Long-Term Housing rates

Holston, Laubach & Williams r^*



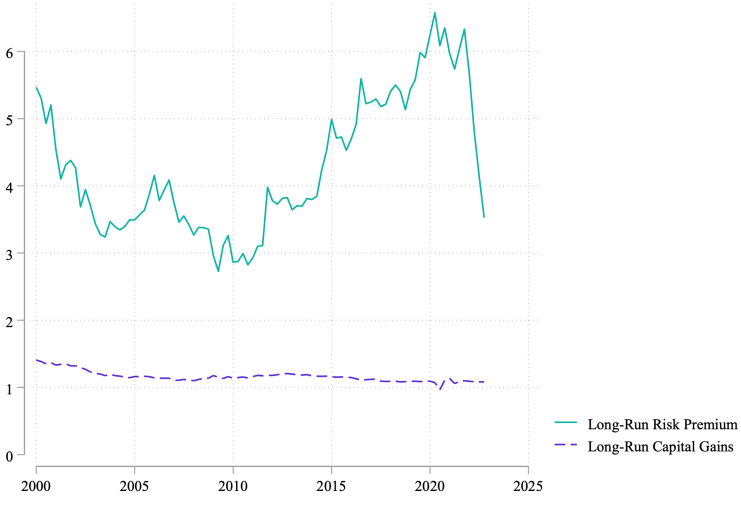
(a) Pre COVID-19 Pandemic



(b) Post COVID-19 Pandemic

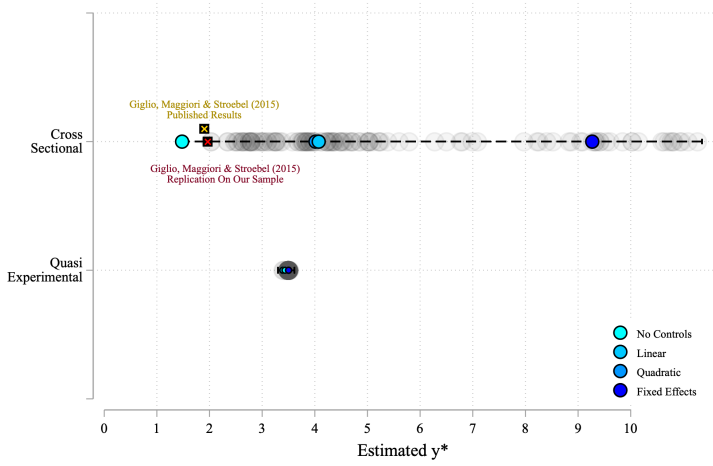
◂ Result # 1

Risk Premia and Capital Gains for Housing



No trend in long run risk premia or capital gains Return

Robustness to Unobserved Heterogeneity: Stability of Estimates



Estimates of y^* from quasi-experimental approach are insensitive to observed heterogeneity

- Estimates of y^* from cross-sectional approach are more sensitive (cf. Giglio, Maggiori & Stroebel 2015)